FINAL REPORT

# DISCHARGE ALTERNATIVES FEASIBILITY STUDY

Required by National Pollutant Discharge Elimination System (NPDES) General Permit CAG280000

**December 21, 2006**

**Submitted to**
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EPA Region IX
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# DISCLAIMER

It should be noted that the operators participating in this study have made good faith estimates for anticipated future volumes of produced water, drill cuttings and drilling mud in order to evaluate economic and other relevant factors within the scope of this study. Various techniques were used to make these estimates and in every case there are numerous uncertainties that could result in the actual future volumes being different than the estimated future volumes used in this study. Furthermore, the estimates of volumes provided in this study are not intended to constitute a waiver of any rights to discharge the full amounts authorized by the applicable NPDES General Permit.

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# EXECUTIVE SUMMARY

## E.1 INTRODUCTION

This feasibility study presents a platform-by-platform evaluation of the economic, environmental, social, and technological feasibility of implementing industry accepted alternatives to the permitted discharge of drilling muds and cuttings, and produced water to the Pacific Ocean. This Feasibility Study is based on information obtained from the operators of the 14 offshore platforms listed below:

- Aera Energy LLC (Aera): Platforms Elly/Ellen and Eureka
- Arguello Inc. (Arguello): Platforms Harvest, Hermosa, and Hidalgo
- ExxonMobil: Platforms Harmony, Heritage, Hondo
- Plains Exploration and Production (PXP): Platform Irene
- Pacific Operators Offshore LLC (POOLLC): Platforms Hogan, Houchin
- Venoco Inc. (Venoco): Platforms Gail and Grace

Information and data were collected from many sources, including literature searches, reviews of current State and Federal environmental protection regulations, and reviews of industry practices.

Data collection also included requesting platform-specific information and supporting data from each operator. To aid in the data collection and to maintain a general uniformity of the information submittals, a questionnaire was developed. The questionnaire focused on eight data sets:

Table 1. Platform Specific Information
Table 2. Water-based Drilling Muds (WBM) & Drill Cuttings
Table 3. Synthetic-based Drilling Muds (SBM) & Drill Cuttings
Table 4. Oil-based Drilling Muds (OBM) & Drill Cuttings
Table 5. Produced Water
Table 6. Air Quality Impact Assessment
Table 7. Disposal Activities - Reinjection
Table 8. Disposal Activities – Preferred Options

In general, the questionnaire requested data for the years 2000 through 2010. The selection of this 10-year time period was to provide for the evaluation of five years of data recorded for historical operations (2000 through 2005) and 5 years of data for projected operations (2006 through 2010).

## E.2 PLATFORM INFORMATION

Platform-specific information was complied for each platform considered in this study. Six of the seven oil and gas operators, responsible for 14 of the 22 platforms participated in this study. Not all platforms currently regulated under the NPDES General Permit discharge produced water or drill muds and cuttings to the ocean. Some platforms are idle, some transfer produced water to adjacent platforms for treatment and discharge. Where the reservoir geology allows, produced water is reinjected into depleted reservoirs. Some platforms pump produced water to shore for treatment and then return it to the platform for discharge. Water-based mud (WBM) and cuttings are almost always discharged from the platform at which drilling occurs. A limited volume of WBM and cuttings have been reinjected. All oil-based muds (OBM) and cuttings are either reinjected or shipped to shore for treatment, landfill disposal or onshore reinjection. The overboard discharge of OBM is prohibited under the NPDES General Permit.

The 14 platforms covered by this feasibility study are located in California Federal Waters off the coast of Santa Barbara, Ventura, and Orange Counties.

## E.3 DISPOSAL ALTERNATIVES

Commercially viable disposal options used throughout the oil and gas industry and their feasibility for use as alternative discharge methods for southern California offshore operators were assessed. The methods include: underground injection (into disposal wells, enhanced oil recovery wells, annular injection, salt caverns); land treatment (land spreading, land farming), thermal treatment, chemical treatment, evaporation, recycling, and landfill disposal.

The following discharge alternatives have been identified as potentially feasible for disposal of drilling muds and cuttings and produced water generated from offshore production and development activities in Southern California:

- Reinjection into geological formations or depleted reservoir formations – Technically feasible for produced water and limited volumes of water-based mud (WBM), oil-based mud (OBM), and cuttings. This option is used by some operators but not all because capacity and flow rates are controlled by reservoir/formation geology. So, while it may be feasible to install a reinjection treatment and pumping system for produced water, WMB, OBM, and cuttings, geological constraints can decrease the effectiveness at many platforms.

- Reinjection using onshore commercial disposal wells - Technically feasible for limited volumes of WBM, OBM, and cuttings (less than 600 barrels per day). This is not a technically feasible option for 100% disposal of all the muds and cuttings, especially the large volumes of WBM and cuttings, generated during drilling operations at any one platform. This is not technically or logistically feasible for the disposal of produced water because of the limited capacity of the onshore disposal well and the large volumes of produced water that are generated daily.

- Landfill disposal – Technically feasible for WBM, OBM, and cuttings, but not produced water.

## E.4 REGULATORY CONSTRAINTS

The regulatory requirements for the disposal of produced water, drilling muds, and drill cuttings are reviewed. The offshore discharge of oil and gas exploration and production wastes is regulated, with the regulations ranging from total prohibition of discharge to limiting the volume that can be discharged, depending upon the characteristics of the waste. OBM and cuttings are prohibited from being discharged overboard. WBM and cuttings are permitted to be discharged, but with a platform-specific limit on the annual volume. Produced water can be discharged provided the concentrations of 26 chemical parameters in the produced water do not exceed permitted limits and the total volume discharged does not exceed the volume permitted for each platform. The discharge limits are specified in the NPDES General Permit.

Onshore disposal of oil and gas exploration and production wastes is regulated also. When offshore wastes are transported onshore, the physical and chemical characteristics need to be analyzed to determine their waste classification before being accepted at a landfill facility.

## E.5 SECONDARY ENVIRONMENTAL IMPACTS

Every waste disposal activity creates environmental impacts. For the overboard disposal of drilling muds and cuttings and produced water, the obvious primary impacts are directly related to the wastes themselves. Drilling muds and cuttings, although dispersed as they fall through the water column, have the potential to create temporary impacts to the water column. Once the discharge reaches the seafloor, physical impacts such as accumulation of material, changes in grain size distribution and smothering of benthic communities can occur, although the existing benthic environment has been changed already, due to the presence of the platform. Chemical impacts to the benthic community can occur also, although the drilling wastes that are permitted to be discharged exhibit low or no toxicity.

For the overboard discharge of produced water, again the obvious primary impacts are directly related to the produced water and its constituents as the discharge plume is diluted within the mixing zone. Physical impacts from changes in temperature or density occur only within the near-field mixing zone during the period of dilution. By the time the produced water plume reaches the edge of the mixing zone, it has been diluted with the receiving water generally by 1,000 times or more. The NPDES General Permit requirements restrict the concentrations of identified pollutants that can be discharged in the produced water to levels such that, at the edge of the mixing zone, the pollutant concentrations are less than the water quality criteria required by the Clean Water Act.

There are secondary impacts related to the overboard discharge of produced water, WBM, and cuttings. The major sources of impacts are the emissions to the atmosphere from the treatment and discharge equipment. For example, the exhaust gases from the generators or motors used to power the discharge pumps, the mud and cuttings separation equipment, and the produced water treatment equipment.

The alternatives to overboard discharge include reinjection into depleted reservoirs or other formations suitable for receiving produced water or muds or transport of the wastes to another location, generally onshore, for disposal. The significant secondary impacts associated with transportation are atmospheric emissions and accidental releases. Transporting the wastes to shore must be accomplished by pumping through a pipeline or by carrying via supply boat and truck. Pump and motor exhaust emissions are unavoidable and can be a source of substantial secondary impacts to the environment. Accidental spills can be avoided through appropriate handling procedures but they do occur infrequently and they have the potential to create significant environmental impacts. Reinjection of produced water into the reservoirs may involve additional secondary impacts compared to overboard discharge because the pumping capacity must be greater to overcome formation pressures.

## E.6 RESULTS OF FEASIBILITY ASSESSMENT

An assessment of the feasibility of the three identified alternative discharge options was conducted for each of the platforms operated by the participating offshore oil and gas producers. The results of the assessments are summarized in the following tables.

The only potentially viable alternative to the overboard discharge of produced water from the platforms is injection into suitable geological formations via existing production wells or by purpose-drilled injection wells. Six of the 14 platforms in the study inject produced water in volumes ranging from less than 1 percent of the total volume generated to 100 percent of the volume generated. Five platforms discharge 100 percent of the produced water overboard and three platforms are idle or do not generate produced water (Table E-1).

Only one platform, Platform Elly/Ellen, currently injects 100 percent of produced water. Injection of 100 percent of produced water was not assessed as feasible at any other platform. Insufficient data were available to determine feasibility at Platform Eureka because is has been idle for more than 10 years and future plans are unknown because it is in the process of changing operators.

Injection of 100 percent of WBM and cuttings has been assessed as not feasible at any platform, commonly as a result of the costs associated with the purchase and installation of injection pumps and the need to expand the existing deck space on the platform for mud storage and to accommodate the injection equipment (Table E-2). Injection of WBM and cuttings occurs at only two platforms (Harmony and Heritage) where only 20 percent of the WBM generated are injected.

Transport of WBM and cuttings to shore for disposal has been assessed as not feasible for any platform (Table E-3). The potential to create additional secondary environmental impacts from additional air emissions from the transporting vessels and trucks is a common factor. The relatively high combined cost of transport and disposal fees is also a common factor. WBM and cuttings are transported to shore for disposal from only two platforms, Gail and Hogan. Both platforms transport about 40 percent of the WBM and /or cuttings to shore and the remainder is discharged overboard. The mud and cuttings that are transported to shore are normally not suitable for discharge overboard.

Overall, the potential for increased environmental impacts from additional air emissions and the significant increase in capital and operating costs relative to current operations were the most common factors that resulted in the alternatives to discharge being assessed as not feasible.

**Table 1.**
**Feasibility Assessment - Produced Water Injection as an Alternative to Discharge Overboard**

| Operator/ Platform | Current Practice | Environment | Technology | Economics | Social | Time |
|---|---|---|---|---|---|---|
| **Venoco** | | | | | | |
| Gail | 94% injected<br>6% discharged overboard | U | Y | Y | Y | Y |
| Grace | Idle<br>Planned restart in 2007; to be piped to Gail for injection | U | Y | Y | Y | Y |
| **POOLLC** | | | | | | |
| Hogan | Piped to shore for treatment.<br>Piped back to Hogan for discharge overboard. | N | U | N | U | Y |
| Houchin | Piped to Hogan, then to shore for treatment.<br>Piped back to Hogan for discharge overboard. | N | U | N | U | Y |
| **PXP** | | | | | | |
| Irene | 2000-2007 100% injected onshore.<br>2008-2010 100% discharge overboard. | N | U | N | U | Y |
| **ExxonMobil** | | | | | | |
| Harmony | 100% piped to shore for treatment.<br>Piped back to Harmony for discharge overboard. | N | N | N | U | Y |
| Heritage | 100% piped to Harmony, then piped to shore for treatment.<br>Piped back to Harmony for discharge overboard. | N | U | N | U | Y |
| Hondo | 100% Piped to Harmony, then piped to shore for treatment.<br>Piped back to Harmony for discharge overboard. | N | U | N | U | Y |
| **Arguello** | | | | | | |
| Harvest | >99% discharged overboard<br><1% injected | N | U | N | U | Y |
| Hermosa | 97-99% discharged overboard<br>1-3% injected | N | N | N | U | Y |
| Hidalgo | 85% discharged overboard<br>15% injected | N | U | N | U | Y |
| **Aera** | | | | | | |
| Elly/Ellen | 100% injection | Y | U | Y | Y | Y |
| Eureka | Idle<br>Planned restart with new operator | U | U | U | U | U |

Notes: Y – Feasible, N – Not feasible, U - Uncertain

**Table 2.**
**Feasibility Assessment - WBM & Cuttings Injection as an Alternative to Discharge Overboard**

| Operator/ Platform | Current Practice | Environment | Technology | Economics | Social | Time |
|---|---|---|---|---|---|---|
| **Venoco** | | | | | | |
| Gail | 2002:<br>100% Discharged Overboard<br>2005:<br>Discharged Overboard<br>60% WBM / 28% Cuttings<br>2005:<br>Transported to Shore<br>40% WBM / 72% Cuttings | Y | N | N | Y | N |
| Grace | Idle<br>Planned restart in 2007 | Y | N | N | Y | N |
| **POOLLC** | | | | | | |
| Hogan | 60% Discharged Overboard<br>40% to shore (owner-operated facility) | N | U | N | N | Y |
| Houchin | 2000-2006: None generated<br>2007-2009: 100% discharge overboard | N | U | N | N | Y |
| **PXP** | | | | | | |
| Irene | 100% Discharged overboard | N | N | N | N | Y |
| **ExxonMobil** | | | | | | |
| Harmony | 80% Discharged overboard<br>20% Injected | N | U | N | N | Y |
| Heritage | 80% Discharged overboard<br>20% Injected | N | U | N | N | Y |
| Hondo | 100% Discharged overboard | N | U | N | N | Y |
| **Arguello** | | | | | | |
| Harvest | 100% Discharged overboard | N | N | N | N | Y |
| Hermosa | 100% Discharged overboard | N | N | N | N | Y |
| Hidalgo | 100% Discharged overboard | N | U | N | N | Y |
| **Aera** | | | | | | |
| Elly/Ellen | None generated | U | U | N | N | U |
| Eureka | Idle - None generated | U | U | U | U | U |

Notes: Y – Feasible, N – Not feasible, U - Uncertain

**Table 3.**
**Feasibility Assessment -WBM & Cuttings Transport to Shore as an Alternative to Discharge Overboard**

| Operator/ Platform | Current Practice | Environment | Technology | Economics | Social | Time |
|---|---|---|---|---|---|---|
| **Venoco** | | | | | | |
| Gail | 2002:<br>100% Discharged Overboard<br>2005:<br>Discharged Overboard<br>60% WBM / 28% Cuttings<br>2005:<br>Transported to Shore<br>40% WBM / 72% Cuttings | U | U | N | Y | N |
| Grace | Idle<br>Planned restart in 2007 | U | U | N | Y | N |
| **POOLLC** | | | | | | |
| Hogan | 60% Discharged Overboard<br>40% to shore (owner-operated facility) | U | Y | N | N | Y |
| Houchin | 2000-2006: None generated<br>2007-2009: 100% discharge overboard | U | Y | N | N | Y |
| **PXP** | | | | | | |
| Irene | 100% Discharged overboard | N | Y | N | N | U |
| **ExxonMobil** | | | | | | |
| Harmony | 80% Discharged overboard<br>20% Injected | N | U | N | N | Y |
| Heritage | 80% Discharged overboard<br>20% Injected | N | U | N | N | Y |
| Hondo | 100% Discharged overboard | N | U | N | N | Y |
| **Arguello** | | | | | | |
| Harvest | 100% Discharged overboard | N | Y | N | N | Y |
| Hermosa | 100% Discharged overboard | N | Y | N | N | Y |
| Hidalgo | 100% Discharged overboard | N | Y | N | N | Y |
| **Aera** | | | | | | |
| Elly/Ellen | None generated | U | Y | U | U | U |
| Eureka | Idle - None generated | U | U | U | U | U |

Notes: Y – Feasible, N – Not feasible, U - Uncertain

# 1.0 INTRODUCTION

On behalf of Western States Petroleum Association (WSPA), Tetra Tech, Inc. (Tetra Tech) has prepared the following Alternatives to Discharge Feasibility Study (Feasibility Study) in compliance with U.S. Environmental Protection Agency (U.S. EPA) National Pollutant Discharge Elimination System (NPDES) General Permit CAG280000 (General Permit).

The NPDES General Permit regulates 22 types of discharge to the surrounding waters "from all exploratory facilities operating within the permit area and development and production facilities which are not new sources including the following: Platforms A, B, C, Edith, Ellen/Elly, Eureka, Gail, Gilda, Gina, Grace, Habitat, Harmony, Harvest, Henry, Heritage, Hermosa, Hillhouse, Hidalgo, Hogan, Hondo, Houchin, and Irene." Produced water and drilling fluids (muds and cuttings) are two of the 22 regulated discharges covered by the NPDES General Permit. This Feasibility Study presents an evaluation of the economic, environmental, social, and technological feasibility of implementing industry accepted alternatives to the permitted discharge of drilling muds and cuttings, and produced water to the Pacific Ocean (ocean). This Feasibility Study is based on information obtained from the operators of the 14 offshore platforms listed below:

- Aera Energy LLC (Aera): Platforms Elly/Ellen and Eureka
- Arguello Inc. (Arguello): Platforms Harvest, Hermosa, and Hidalgo
- ExxonMobil: Platforms Harmony, Heritage, and Hondo
- Plains Exploration and Production (PXP): Platform Irene
- Pacific Operators Offshore LLC (POOLLC): Platforms Hogan and Houchin
- Venoco Inc. (Venoco): Platforms Gail and Grace

The study is a joint submittal for the above listed operators and does not include all facilities listed in the NPDES General Permit.

## 1.1 PURPOSE AND APPROACH

The purpose of this Feasibility Study is to comply with the NPDES General Permit requirement that states:

> "Within two years of the effective date of this permit, each permittee operating under this permit shall submit to EPA a study or studies to determine the feasibility, as defined in the California CMP, of disposal of drill muds and cuttings and produced water by means other than discharge into ocean waters (e.g., injection and barging). A platform-by-platform analysis will be included. The study shall include an analysis of the continued feasibility of injection of produced water for those platforms

> which currently inject produced water, and those platforms which currently do not discharge produced water. This permit will be reopened and modified to require additional effluent limitations if alternative means of disposal are determined to be feasible. (Alternatively, permittees may jointly submit the reports; joint submittals shall constitute compliance for those permittees who participate in the preparation of the reports.)"

"Feasibility" is defined in the California Coastal Management Plan (CMP) as:

> "'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." (Calif. Public Resource Code Section 300100-30122 California Coastal Act, Section 2 Definitions).

This Feasibility Study provides a platform-by-platform evaluation of alternatives to the discharge of drilling muds, drill cuttings, and produced water to the ocean through:

- Collection of historical and proposed platform-specific operational and discharge information provided by the platform operators. A detailed questionnaire was submitted to the participating operators to obtain this information;
- Collection of technical information on discharge alternatives that are in use throughout the industry, including alternatives used offshore in California;
- Review of federal and state regulatory requirements pertaining to disposal alternatives;
- Review of available published and unpublished reports and studies on disposal technologies and impacts;
- Evaluation of secondary environmental impacts associated with the technically viable disposal alternatives; and
- Making a conclusion regarding the feasibility of each discharge alternative identified as being a conceptually viable alternative for southern California.

This report is organized into the following sections:

Section 1.0 Introduction

Section 2.0 Platform Information and Discharge Practices

Section 3.0 Disposal Alternatives

Section 4.0 Regulatory Constraints on Disposal Alternatives

Section 5.0 Secondary Environmental Impacts of Disposal Alternatives

Section 6.0 Discharge Alternatives Feasibility Analysis, Aera Energy LLC

Section 7.0 Discharge Alternatives Feasibility Analysis, Arguello Inc.

Section 8.0 Discharge Alternatives Feasibility Analysis, ExxonMobil

Section 9.0 Discharge Alternatives Feasibility Analysis, Pacific Operators Offshore LLC

Section 10.0 Discharge Alternatives Feasibility Analysis, Plains Exploration and Production

Section 11.0 Discharge Alternatives Feasibility Analysis, Venoco Inc.

Section 12.0 References

Appendix A Questionnaire

Appendix B Air Quality Analyses

## 1.2 DATA COLLECTION METHODOLOGY

Information and data were collected from many sources, including:

- Literature searches to identify disposal methods used and regulated in other oil production areas worldwide;
- Reviewing current State and Federal environmental protection regulations that address discharges to ocean waters, discharges to the atmosphere, protection of groundwater quality, hazardous and non-hazardous waste disposal activities, etc.;
- Reviewing industry practices for the treatment of produced water, drilling muds, and cuttings;
- Characterizing the chemical constituents of concern in drilling muds and produced waters that are discharged offshore California;
- Quantifying the volumes of drilling muds and cuttings and produced water that are generated, treated, and disposed from each platform participating in this study;
- Identifying economic factors affecting the viability of alternate disposal methods, including treatment and transportation costs and capital and operating costs;
- Identifying secondary environmental impacts associated with viable alternative disposal options; and
- Assessing the identified alternative disposal methods for each platform, using a standard set of criteria.

Data collection also included requesting platform-specific information and supporting data from each operator. To aid in the data collection and to maintain a general uniformity of the information submittals, a questionnaire was developed. The questionnaire focused on eight data sets:

Table 1. Platform Specific Information

Table 2. Water-based Drilling Muds & Drill Cuttings

Table 3. Synthetic-based Drilling Muds & Drill Cuttings

Table 4. Oil-based Drilling Muds & Drill Cuttings

Table 5. Produced Water

Table 6. Air Quality Impact Assessment

Table 7. Disposal Activities – Injection

Table 8. Disposal Activities – Preferred Options

In general, the questionnaire requested data for the years 2000 through 2010. The selection of this 10-year time period was to provide for the evaluation of five years of data recorded for historical operations (2000 through 2005) and 5 years of data for projected operations (2006 through 2010). Company representatives from Aera, Arguello, ExxonMobil, PXP, POOLLC, Venoco, and/or their consultants were requested to complete one questionnaire for each of their respective offshore platforms. Tetra Tech representatives provided assistance to the operators through phone communication, conference calls, and electronic mail (email).

Additional documentation was requested from the operators to supplement the questionnaire. The requested documents included:

- 2006 Quarterly Discharge Monitoring Report (most recent).
- Synopses of offshore and onshore produced water injection evaluations.
- Descriptions of treatment equipment and processes for drilling muds and cuttings, drill muds, and produced water.

The operators were encouraged to provide any additional comments they thought pertinent to address the questions. Due to data confidentiality, copies of the completed questionnaires and supplemental documents have not been included in this report.

# 2.0 PLATFORM INFORMATION AND DISCHARGE PRACTICES

The NPDES General Permit CAG280000 (NPDES General Permit) that came into effect in December 2004 regulates the discharges from 22 oil and gas production platforms operating in California Federal Waters off southern California. Six of the seven oil and gas operators, responsible for 14 of the 22 platforms, participated in this study. Not all platforms currently regulated under the NPDES General Permit discharge produced water or drilling muds and cuttings to the ocean. Some platforms are idle, and some transfer produced water to adjacent platforms for treatment and discharge. Where the reservoir geology allows, produced water is injected into depleted reservoirs. Some platforms pump produced water to shore for treatment and then return it to the platform for discharge. Water-based mud (WBM) and cuttings are almost always discharged from the platform at which drilling occurs. A limited volume of WBM and cuttings have been injected. All oil-based muds (OBM) and cuttings are either injected or shipped to shore for treatment, landfill disposal or onshore injection. The overboard discharge of OBM is prohibited under the NPDES General Permit.

The 14 platforms covered by this feasibility study are located in California Federal Waters off the coast of Santa Barbara, Ventura, and Orange Counties (Figure 2-1). General information on platform location is presented in Table 2-1. A summary of general information for each of the platforms is presented in report sections 2.1 through 2.6.

**Table 2-1**
**General Summary of Platform Location and Oil Production**

| Platform | Operator | Lease Block | Latitude, North | Longitude, West | Oil Production Status |
|---|---|---|---|---|---|
| Elly/Ellen | Aera | OCS 300 | 33º 34' 56" | 118º 07' 39" | Active |
| Eureka | Aera | OCS 300 | 33º 33' 50" | 118º 07' 00" | Idle |
| Irene | PXP | OCS-P 0441 | 34º 36' 26" | 120º 43' 40" | Active |
| Harvest | Arguello | OCS-P 0315 | 34º 28' 42" | 120º 40' 46.169" | Active |
| Hermosa | Arguello | OCS-P 0316 | 34º 27' 19" | 120º 38' 47" | Active |
| Hidalgo | Arguello | OCS-P 0450 | 34º 29' 42.06" | 120º 42' 08.44" | Active |
| Hogan | POOLLC | OCS P-0166 | 34º 20' 16" | 119º 32' 29" | Active |
| Houchin | POOLLC | OCS P-0166 | 34º 20' 06" | 119º 33' 08" | Active |
| Harmony | ExxonMobil | OCS P-0190 | 34º 22' 36.03" | 120º 10' 03.09" | Active |
| Heritage | ExxonMobil | OCS P-0182 | 34º 21' 01.41" | 120º 16' 45.08" | Active |
| Hondo | ExxonMobil | OCS P-0188 | 34º 23' 26.63" | 120º 07' 13.91" | Active |
| Gail | Venoco | OCS P-0205 | 34º 07' 33" | 119º 24' 1" | Active |
| Grace | Venoco | OCS P-0217 | 34º 10' 47" | 119º 28' 05" | Idle |

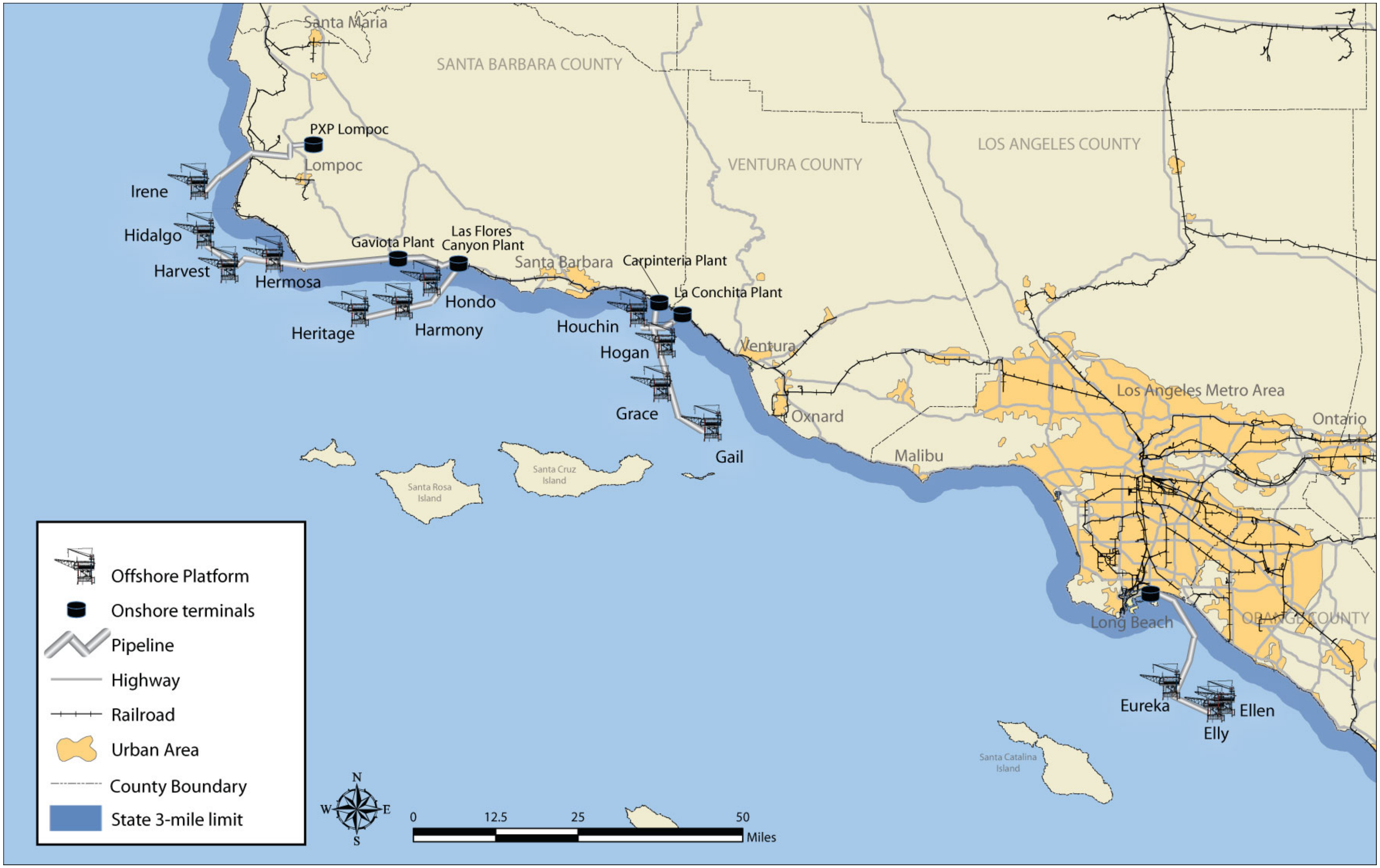
Santa Maria
SANTA BARBARA COUNTY
PXP Lompoc
Lompoc
Irene
Hidalgo
Harvest
Hermosa
Gaviota Plant
Las Flores Canyon Plant
Hondo
Harmony
Heritage
Santa Barbara
Carpinteria Plant
La Conchita Plant
Houchin
Hogan
Grace
Gail
VENTURA COUNTY
Ventura
Oxnard
Malibu
LOS ANGELES COUNTY
Los Angeles Metro Area
Ontario
Long Beach
ORANGE COUNTY
Eureka
Ellen
Elly
Santa Rosa Island
Santa Cruz Island
Santa Catalina Island
Offshore Platform
Onshore terminals
Pipeline
Highway
Railroad
Urban Area
County Boundary
State 3-mile limit
N
S
E
W
0
12.5
25
50
Miles

**Figure 2-1**

## 2.1 AERA ENERGY LLC, PLATFORMS ELLY/ELLEN AND EUREKA

### Location

Aera is the owner/operator of Platforms Elly/Ellen and Eureka. Platforms Elly/Ellen are located on offshore lease tract OCS 300, at a distance of approximately 9 miles offshore of the City of Huntington Beach (Figure 2-1). Power for each platform is supplied by onboard generators using reservoir gas and diesel fuel.

Platforms Elly and Ellen are located immediately adjacent to one another and connected by a walk bridge. Platforms Elly and Ellen are discussed herein as one production platform Elly/Ellen.

### Production

As current owner of Platforms Elly/Ellen, Aera has no plans to drill additional oil wells. However, Platforms Elly/Ellen are under purchase evaluation by an oil production operator who is anticipated to drill additional oil wells to add value to the platform production operations.

Platform Eureka is currently idle and has not generated drilling muds, drill cuttings or produced water for more than seven years. However, Platform Eureka is under purchase evaluation by an oil production operator who is anticipated to drill additional oil wells and re-establish oil production operations.

### Produced Water Discharge

All produced water at Platforms Elly/Ellen is injected. Discharges of produced water to the ocean would only occur in an upset condition. If produced water discharges to the ocean were prohibited, production operations would be shut-in (stopped) when the injection system is not in operation.

If oil production operations are reestablished at Platform Eureka, it is expected that produced water would be injected.

### Mud & Cuttings Discharge

Platforms Elly/Ellen has not utilized any drilling muds or generated any drill cuttings for more than ten years. No information regarding future disposition of drilling muds and cuttings at Platform Elly/Ellen was available.

No information regarding future plans for disposition of drilling muds and cuttings at Platform Eureka was available from the potential buyer.

**Table 2-2**
**Platforms Elly/Ellen and Eureka Waste Types, Volumes, and Discharge Methods for 2000 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Elly/Ellen** | | | | | | |
| Produced Water | 24,500,000 | 0 | 24,500,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | Water-based drilling muds are not utilized at Platform Elly/Ellen. | | | | | |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Elly/Ellen. | | | | | |
| **Platform Eureka**(1) | | | | | | |
| Produced Water | Platform Eureka is idle and does not generate produced water. | | | | | |
| Water-Based Drilling Muds | Water-based drilling muds are not utilized at Platform Eureka. | | | | | |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Eureka. | | | | | |

Notes: 1. Platform Eureka has been idle with no production or drilling activities for more than 10 years.

**Table 2-3**
**Platforms Elly/Ellen and Eureka Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume(1) (bbls) | Discharged To Ocean(1) (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Elly/Ellen** | | | | | | |
| Produced Water (1) | 10,950,000 | 10,950,000 | DNP | DNP | DNP | DNP |
| Water-Based Drilling Muds | DNP | DNP | DNP | DNP | DNP | DNP |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | DNP | DNP | DNP | DNP | DNP | DNP |
| **Platform Eureka** (2) | | | | | | |
| Produced Water | DNP | DNP | DNP | DNP | DNP | DNP |
| Water-Based Drilling Muds | DNP | DNP | DNP | DNP | DNP | DNP |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | DNP | DNP | DNP | DNP | DNP | DNP |

Notes: 1. Data not provided. The maximum annual permitted volume as published in the NPDES General Permit No. CAG280000 is used.

2. Platform Eureka has been idle with no production or drilling activities for more than 10 years.

## 2.2 ARGUELLO INC., PLATFORMS HARVEST, HERMOSA, AND HIDALGO

### Location

Arguello is the operator for Platforms Harvest, Hermosa, and Hidalgo, which are located a distance of approximately 6.7, 6.8, and 5.9 miles offshore of Santa Barbara County, respectively. All three platforms are eight-leg, five-deck platforms. Platforms Harvest and Hermosa were installed in water depths of 675 and 603 feet, respectively during 1985. Platform Hidalgo was installed in 430 of water in 1986.

### Production

Platforms Harvest, Hermosa, and Hidalgo all produce sour natural gas and crude oil from offshore lease tracts OCS P-0315, P-0316, and P-0450, respectively. Oil/water emulsion from Platform Hidalgo undergoes initial processing to reduce water and sediment content prior to being shipped via sub-sea pipelines to Platform Hermosa. Stabilized, merchantable oil and gas from Platforms Harvest, Hermosa, and Hidalgo are shipped from Platform Hermosa via sub-sea pipelines to the Gaviota Oil Heating Facility. Primary power to all three platforms is supplied by onboard turbine generators fueled by produced natural gas.

### Produced Water Discharge

From 2000 and 2006 produced water generated at Platforms Harvest, Hermosa, and Hidalgo was discharged to the ocean at percentages ranging from approximately 85 to 99 percent of the total volume of produced water generated per platform. The remaining produced water volumes were injected. All produced water is treated on-platform through a series of oil-water coalescers and flotation cell equipment to meet discharge quality specifications prior to discharge or injection. No changes are planned in the proportions of produced water to be injected and discharged at all three platforms in the period between 2007 through 2010.

### Mud & Cuttings Discharge

WBM were used at Platforms Harvest and Hidalgo between 2000 and 2006. All WBM and cuttings generated were discharged to the ocean. Only WBM is anticipated to be utilized in 2007 through 2010. One-hundred percent of the WBM and cuttings generated at Platforms Hermosa and Hidalgo are anticipated to be discharged to the ocean in 2007 through 2010, if drilling takes place. One-hundred percent of the WBM and cuttings generated at Platform Harvest are anticipated to be discharged to the ocean from 2007 to 2010.

No SBM were utilized at Platforms Harvest, Hermosa, or Hidalgo during 2000 through 2006. Platform Hidalgo used OBM in 2004, 2005, and 2006. Approximately 95 to 96 percent of the OBM and cuttings generated between 2004 and 2006 was injected. The remaining volumes were transported to shore for recycling. No OBM were used at Harvest or Hermosa between 2000 and 2006. No SBM or OBM are anticipated to be utilized in 2007 through 2010.

**Table 2-4**
**Platforms Harvest, Hermosa, and Hidalgo Waste Types, Volumes, and Discharge Methods for 2000 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Harvest** | | | | | | |
| Produced Water* | 65,643,000 | 65,207,000 | 436,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 31,327 | 31,327 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 1,771 | 1,771 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Harvest. | | | | | |
| **Platform Hermosa** | | | | | | |
| Produced Water* | 79,206,000 | 77,946,000 | 1,260,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | Water-based drilling muds were not utilized at Platform Hermosa. | | | | | |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Hermosa. | | | | | |
| **Platform Hidalgo** | | | | | | |
| Produced Water* | 16,571,000 | 13,990,000 | 2,581,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 61, 000 | 61, 000 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 11,900 | 11,900 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds (Volume Includes Drill Cuttings) | 140,600 | 0 | 133,937 | 0 | 6,634 | 0 |

Note * NPDES General Permit annual discharge volumes (bbls) are: Platform Harvest 32,850,000; Platform Hermosa 40,250,000 and Platform Hidalgo 18,250,000.

**Table 2-5**
**Platforms Harvest, Hermosa, and Hidalgo Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Harvest** | | | | | | |
| Produced Water | 71,609,000 | 71,461,000 | 148,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 94,000 | 94,000 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 25,600 | 25,600 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Harvest. | | | | | |
| **Platform Hermosa** | | | | | | |
| Produced Water | 81,249,987 | 80,414,607 | 835,380 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 94,000 | 94,000 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 25,600 | 25,600 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Hermosa. | | | | | |
| **Platform Hidalgo** | | | | | | |
| Produced Water | 17,937,000 | 15,997,000 | 1,940,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 94,000 | 94,000 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 25,600 | 25,600 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Hidalgo. | | | | | |

## 2.3 EXXONMOBIL, PLATFORMS HARMONY, HERITAGE, AND HONDO

### Location

ExxonMobil is the sole owner and operator of Platforms Harmony, Heritage, and Hondo, located on offshore lease tracts OCS P-0190, OCS P-0182, and OCS P-0188, respectively. Platforms Harmony, Heritage, and Hondo are all located approximately 25 miles west of the City of Santa Barbara at approximately 6.4, 7.9, and 5.5 miles from shore, respectively (Figure 2-1).

Platforms Harmony and Heritage are eight-leg, 60-well slot platforms installed in water depths of 1,200 and 1,075 feet, respectively during 1989 to 1992. Platform Hondo is an eight-leg, 28-well slot platform that was installed in a water depth of 850 feet in 1976.

### Production

Platforms Harmony, Heritage, and Hondo all produce sour natural gas and crude oil. Oil/water emulsion from Platforms Heritage and Hondo are shipped via sub-sea pipeline to Platform Harmony. Oil/water emulsion from Platforms Harmony, Heritage, and Hondo are then shipped via sub-sea pipeline to ExxonMobil’s onshore processing facilities in Las Flores Canyon located approximately 20 miles west of the City of Santa Barbara. The design production rate at Platforms Harmony, Heritage, and Hondo is 75,000 bbls of oil/water emulsion per day for each platform. Primary power for each platform is supplied via a sub-sea cable from ExxonMobil’s onshore 49 Megawatt (MW) cogeneration power plant in Las Flores Canyon and the state electricity grid.

### Produced Water Discharge

All produced water from Platforms Harmony, Heritage, and Hondo is treated at the Las Flores Canyon processing facility and shipped via sub-sea pipeline for discharge to the ocean at Platform Harmony. This process remains viable for the period 2007 through 2010.

### Mud & Cuttings Discharge

WBM were utilized at Platform Harmony in 2002 and 2003, in 2000 through 2006 for Platform Heritage, and in 2000 through 2004 for Platform Hondo. For Platforms Harmony and Heritage, approximately 80 percent of the WBM and cuttings were discharged to the ocean. The remaining 20 percent of WBM and cuttings from Platforms Harmony and Heritage were injected. All WBM and cuttings from Platform Hondo were discharged to the ocean. For this analysis, future WBM and cuttings discharges to the ocean from Platforms Harmony and Heritage will be assumed to remain at 80 percent for the period between 2007 and 2010. Future WBM and cuttings discharges to the ocean from Platform Hondo will remain at 100 percent for the period between 2007 through 2010.

OBM were utilized at Platform Harmony in 2003, in 2000 through 2006 for Platform Heritage, and in 2000, 2001, 2002, and 2004 for Platform Hondo. For Platform Harmony, approximately 83 percent of the OBM and 100 percent of the cuttings were injected. The remaining 17 percent of the OBM were transported to shore for recycling. For this analysis, 2007 through 2010, 83 percent of the OBM and 100 percent of the cuttings are anticipated to be injected from Platform Harmony. The remaining 17 percent of OBM are anticipated to be transported to shore for recycling.

For Platform Heritage, approximately 80 percent of the OBM and 100 percent of the cuttings were injected. The remaining 20 percent of the OBM were transported to shore for recycling. For 2007 through 2010, 80 percent of the OBM and 100 percent of the cuttings are anticipated to be injected from Platform Heritage, with the remaining 20 percent of OBM to be transported to shore for recycling.

For Platform Hondo, 59 percent of the OBM and 100 percent of the cuttings, generated between 2000 and 2004, were injected, and the remaining 41 percent of the OBM were transported to shore for recycling. For 2007 through 2010, no changes are expected in the proportions of muds and cuttings that are injected or recycled when drilling.

**Table 2-6**
**Platforms Harmony, Heritage, and Hondo Waste Types, Volumes, and Discharge Methods for 2000 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean * (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Harmony** | | | | | | |
| Produced Water | 37,800,000 | 37,800,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 155,880 | 124,704 | 31,176 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 20,784 | 16,627 | 4,157 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 17,565 | 0 | 11,710 | 0 | 2,928 | 0 |
| Oil-Based Drill Cuttings | 5,855 | 0 | 5,855 | 0 | 0 | 0 |
| **Platform Heritage** | | | | | | |
| Produced Water | 40,600,000 | 40,600,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 628,522 | 502,817 | 125,704 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 83,803 | 67,042 | 16,761 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 84,300 | 0 | 67,440 | 0 | 16,860 | 0 |
| Oil-Based Drill Cuttings | 33,720 | 0 | 33,720 | 0 | 0 | 0 |
| **Platform Hondo** | | | | | | |
| Produced Water | 17,500,000 | 17,500,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 75,610 | 75,610 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 10,080 | 10,080 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 18,095 | 0 | 0 | 10,676 | 7,419 | 0 |
| Oil-Based Drill Cuttings | 5,400 | 0 | 0 | 5,400 | 0 | 0 |

Note: * After treatment onshore.

**Table 2-7**
**Platforms Harmony, Heritage, and Hondo Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Harmony** | | | | | | |
| Produced Water | 21600,000 | 21,600,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 525,000 | 420,000 | 105,000 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 70,000 | 56,000 | 14,000 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 96,000 | 0 | 79,680 | 0 | 16,320 | 0 |
| Oil-Based Drill Cuttings | 32,000 | 0 | 32,000 | 0 | 0 | 0 |
| **Platform Heritage** | | | | | | |
| Produced Water | 49,300,000 | Discharged at Platform Harmony | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 600,000 | 480,000 | 120,000 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 80,000 | 64,000 | 16,000 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 96,000 | 0 | 76,800 | 0 | 19,200 | 0 |
| Oil-Based Drill Cuttings | 32,000 | 0 | 32,000 | 0 | 0 | 0 |
| **Platform Hondo** | | | | | | |
| Produced Water | 9,600,000 | Discharged at Platform Harmony | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 225,000 | 225,000 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 30,000 | 30,000 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 45,000 | 0 | 0 | 45,000 | 0 | 0 |
| Oil-Based Drill Cuttings | 15,000 | 0 | 0 | 15,000 | 0 | 0 |

## 2.4 PACIFIC OPERATORS OFFSHORE LLC (POOLLC), PLATFORMS HOGAN AND HOUCHIN

### Location

POOLLC operates Platforms Hogan and Houchin, located on offshore lease tract OCS-P-0166, approximately 8 and 7 miles, respectively southeast from the City of Santa Barbara (3.7 and 4.1 miles offshore, respectively). Figure 2-1 shows the approximate location of Platforms Hogan and Houchin off the Santa Barbara County coast. Platform Hogan is a nine leg, 66 wellhead slot, platform placed in a water depth of 155 feet. The platform was installed in 1967, drilling operations began in 1968, and the first phase (50 wells) was concluded in 1979. Platform Houchin is a nine leg, 60 wellhead slot, platform placed in a water depth of 163 feet. The platform was installed in 1968, drilling operations began in 1969, and the first phase (43 wells) was concluded in 1980. Primary power to both platforms is supplied by a sub-sea electrical cable connected to the state electricity grid.

### Production

Platform Hogan produces sweet natural gas and crude oil emulsion. Both products are pumped via sub-sea pipelines to POOLLC's La Conchita oil and gas plant in Ventura County. The platform has a design capacity of 15,000 bbls per day of oil/water emulsion and 15 million standard cubic feet per day of natural gas.

Gas, oil, and produced water from Platform Houchin are piped to Platform Hogan and then piped to shore for further treatment. No drilling muds or drill cuttings have been generated from 2000 through 2006 for Platform Houchin.

### Produced Water Discharge

Between 2000 and 2006 all produced water from Platforms Hogan and Houchin was pumped to shore via a sub-sea pipeline and treated at POOLLC's La Conchita treatment facility. The cleaned water was then returned to Platform Hogan via pipeline to be discharged to the ocean. The combined average annual volume of produced water generated at Platforms Hogan and Houchin for 2000 through 2005 was 1.25 million bbls (equivalent to approximately 143,836 gallons per day). An average annual volume of 0.87 million bbls of produced water is forecast for 2006 through 2010. No changes in this treatment and discharge process are planned for the next three years. Produced water generated between 2007 through 2010 is planned also to be discharged to the ocean.

### Mud & Cuttings Discharge

WBM and cuttings were generated at Platform Hogan from 2000 to 2006. A total of 2,495 bbls of WBM were discharged overboard and 1,256 bbls were shipped to shore for disposal. During that same period 2,093 bbls of water-based cuttings were generated, of which 1,256 bbls were discharged overboard and the remainder was transported to shore for treatment at an operator-owned treatment facility. No drilling is planned at Hogan within the next four years (2007-2010).

No WBM or OBM were utilized at Platform Houchin between 2000 and 2006. Drilling is planned at Platform Houchin in 2007 and anticipated to continue into 2009. An estimated 22,400 bbls of WBM are anticipated to be utilized during this period and 16,000 bbls of cuttings are expected to be generated. All WBM and cuttings generated at Platform Houchin that do not pass the sheen test are planned to be transported to shore for treatment at an operator-owned treatment facility. Remaining volumes of WBM and cuttings will be discharged overboard. SBM and OBM drilling muds have not been used at either platform from 2000 to 2006 and are not anticipated to be used between 2007 and 2010.

**Table 2-8**
**Platforms Hogan and Houchin Waste Types, Volumes, and Discharge Methods for 2000 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Hogan** | | | | | | |
| Produced Water | 8,370,000 | 8,370,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 4,158 | 2,495 | 0 | | 0 | 1,663 |
| Water-Based Drilling Cuttings | 2,093 | 1,256 | 0 | | 0 | 837 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Hogan. | | | | | |
| **Platform Houchin** | | | | | | |
| Produced Water | Note 1 | Note 1 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | Water-based drilling muds are not utilized at Platform Houchin. | | | | | |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling M&C | Oil-based drilling muds are not utilized at Platform Houchin. | | | | | |

**Table 2-9**
**Platforms Hogan and Houchin Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Hogan** | | | | | | |
| Produced Water (Note 1) | 3,480,000 | 3,480,000 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 0 | 0 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Cuttings | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Hogan. | | | | | |
| **Platform Houchin** | | | | | | |
| Produced Water | Note 2 | Note 2 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 22,400 | 22,400 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Cuttings | 16,000 | 16,000 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Houchin. | | | | | |

Notes: 1. Produced water is piped to shore for treatment and returned to Platform Hogan for discharge to the ocean. The operator projects the volumes to decrease from previous years due to drilling activities, but these volumes may increase significantly based on the final outcome resulting from the proposed drilling operations.

2. Volume is included in Platform Hogan totals.

## 2.5 PLAINS EXPLORATION AND PRODUCTION (PXP), PLATFORM IRENE

### Location

PXP is the operator of Platform Irene, located on offshore lease tract OCS-P0441, approximately 4 miles west of Point Pedernales (approximately 4.7 miles offshore of Santa Barbara County, Figure 2-1). Platform Irene is an eight-leg, 72 well slot platform that was installed in a water depth of 242 feet in 1985. All equipment on Platform Irene, except two pedestal cranes, emergency generators, and a water pump, are powered by the Pacific Gas & Electric power grid provided by a sub-sea cable from shore.

### Production

Platform Irene produces crude oil and sour natural gas. The oil/water emulsion is shipped via sub-sea pipeline to the company's Lompoc Oil and Gas Plant located approximately 3 miles north of Lompoc, California.

### Produced Water Discharge

Produced water from Platform Irene is treated at the Lompoc Oil and Gas Plant. A portion of the treated water is injected in the nearby onshore Lompoc oilfield and a portion is shipped via sub-sea pipeline for injection at Platform Irene. The average annual volume of produced water generated at Platform Irene was approximately 5.9 million bbls from 2000 to 2006 and is estimated to be 21.3 million bbls from 2007 to 2010. For the period of 2000 through 2006, all produced water was injected. Produced water system upgrades are being designed to allow for reliable water quality for ocean discharge. Future disposal of produced water is to include both injection and discharge to the ocean (25 percent and 75 percent, respectively). Future produced water discharge to the ocean will include treatment prior to discharge.

### Mud & Cuttings Discharge

For the reporting period 2000 to 2006, WMB and cuttings were only generated and discharged in 2006. No OBM or synthetic-based drilling muds (SBM) were used during 2000 to 2006. Future drilling operations are reported to include the use of both WBM and OBM. Approximately 100 percent of the WBM and associated cuttings are estimated to be discharged to the ocean. Disposition of future OBM and cuttings will only be injected.

**Table 2-10**
**Platform Irene Waste Types, Volumes, and Discharge Methods for 2000 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Irene** | | | | | | |
| Produced Water | 41,300,000 | 0 | 41,300,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 11,610 | 11,610 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 1,800 | 1,800 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Irene. | | | | | |

**Table 2-11**
**Platform Irene Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Irene** | | | | | | |
| Produced Water* | 85,300,000 | 63,800,000 | 21,500,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 77,500 | 77,500 | 0 | 0 | 0 | 0 |
| Water-Based Drill Cuttings | 8,733 | 8,733 | 0 | 0 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 80,000 | 0 | 80,000 | 0 | 0 | 0 |
| Oil-Based Drill Cuttings | 14,000 | 0 | 14,000 | 0 | 0 | 0 |

* NPDES General Permit annual discharge volume is 55,845,000 bbls.

## 2.6 VENOCO INC., PLATFORMS GAIL AND GRACE

### Location

Venoco operates Platforms Gail and Grace, located on offshore lease tracts OCS P-0205 and P-0217 respectively, at approximately 8 to 10 miles offshore from Ventura County (Figure 2-1). Power for each platform is supplied by onboard generators using produced natural gas.

### Production

Platform Gail produces oil, natural gas and produced water. All of these products are treated on the platform utilizing oil, water and gas separation, chemical treatment, and clarification. Oil and gas is sent to their onshore facility at Carpinteria for storage and sale. The produced water is treated, filtered, and either injected at the platform or discharged overboard.

### Produced Water Discharge

Between 2002 and 2006, approximately 94 percent of the 35.1 million bbls of produced water generated at Gail was injected. The remaining six percent of produced water was discharged to the ocean. All produced water is treated on-platform prior to discharge or injection.

Platform Grace has been idle for over ten years and has not produced water during that time. Venoco has plans to drill and restore production operations at Platform Grace in 2007. Produced water generated at Platform Grace will be shipped via sub-sea pipeline for injection at Platform Gail.

### Mud & Cuttings Discharge

WBM were utilized at Platform Gail in 2002, 2005, and 2006. In 2002, 100 percent of the WBM and cuttings were discharged overboard at the platform. In 2005, 60 percent of the WBM and 28 percent of the water-based cuttings were discharged overboard at the platform. The remaining 40 percent of the WBM and 72 percent of the water-based cuttings were transported to shore for disposal at a landfill or for onshore injection because they were not suitable for ocean discharge. In 2006, 100 percent of the WBM and cuttings were transported to shore for disposal at a landfill or onshore injection. Future WBM and cuttings discharges to the ocean from

Platform Gail are estimated at approximately 60 percent and 27 percent, respectively. The remaining volumes of WBM and cuttings are anticipated to be transported to shore for landfill disposal. No SBM or OBM were utilized at Platform Gail between 2000 and 2006.

Platform Grace has been idle for over ten years and has not generated drilling muds or drill cuttings during that time. Venoco has plans to drill and restore production operations at Platform Grace in 2007. WBM and OBM are anticipated to be utilized at Platform Grace between 2007 and 2010. Approximately 60 percent of WBM and 28 percent of the cuttings are anticipated to be discharged to the ocean in 2007 through 2010. The remaining volumes of WBM and cuttings are anticipated to be transported to shore for disposal at a landfill or onshore injection well. One-hundred percent of the OBM and cuttings will be injected at Platform Grace for the period of 2007 through 2010. No SBM are planned to be utilized at Platform Grace between 2007 and 2010.

**Table 2-12**
**Platforms Gail and Grace Waste Types, Volumes, and Discharge Methods for 2002 - 2006**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Gail** | | | | | | |
| Produced Water | 35,100,000 | 2,106,000 | 32,994,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 21,151 | 13,283 | 0 | 7,868 | 0 | 0 |
| Water-Based Drill Cuttings | 5,948 | 2,974 | 0 | 2,974 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Gail. | | | | | |
| **Platform Grace** | | | | | | |
| Produced Water | 0 | 0 | 0 | 0 | 0 | 0 |
| Water-Based Drilling Muds | Water-based drilling muds are not utilized at Platform Grace. | | | | | |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Grace. | | | | | |

**Table 2-13**
**Platforms Gail and Grace Waste Types, Volumes, and Discharge Methods Estimated for 2007 - 2010**

| Waste Stream | Total Volume (bbls) | Discharged To Ocean (bbls) | Injected (bbls) | Disposal At Landfill (bbls) | Recycled (bbls) | Other Methods |
|---|---|---|---|---|---|---|
| **Platform Gail** | | | | | | |
| Produced Water | 65,700,000 | 0 | 65,700,000 | 0 | 0 | 0 |
| Water-Based Drilling Muds | 35,080 | 21,048 | 0 | 14,032 | 0 | 0 |
| Water-Based Drill Cuttings | 13,400 | 3,618 | 0 | 9,782 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | Oil-based drilling muds are not utilized at Platform Gail. | | | | | |
| **Platform Grace** | | | | | | |
| Produced Water | 20,000 | 0 | 20,000 at Platform Gail | 0 | 0 | 0 |
| Water-Based Drilling Muds | 35,080 | 21,200 | 0 | 13,880 | 0 | 0 |
| Water-Based Drill Cuttings | 13,400 | 3,760 | 0 | 9,640 | 0 | 0 |
| Synthetic-Based Drilling Muds | Synthetic-based drilling muds are not utilized at any platform. | | | | | |
| Oil-Based Drilling Muds | 35,080 | 0 | 35,080 | 0 | 0 | 0 |
| Oil-Based Drill Cuttings | 13,400 | 0 | 13,400 | 0 | 0 | 0 |

# 3.0 DISPOSAL ALTERNATIVES

Presented below is a summary of the produced water, drilling mud, and drill cuttings disposal practices for the 14 platforms included in the feasibility analysis:

- Produced water treated on platform and discharged to the ocean,
- Produced water piped to shore for treatment and returned to platform for discharge,
- Produced water piped to shore and injected onshore,
- Produced water treated on platform and injected offshore,
- WBM and cuttings discharged to the ocean,
- WBM and cuttings disposal at an approved landfill,
- WBM and cuttings injection,
- OBM recycling,
- OBM and cuttings disposal at a landfill, and
- OBM and cuttings injection.

Presented below is a summary of conceptual disposal options utilized throughout the oil and gas industry and an evaluation of their technological, logistical, and economic feasibility for use as alternative discharge methods for southern California offshore operators. The methods include: underground injection (into disposal wells, enhanced oil recovery wells, annular injection, salt caverns); land treatment (land spreading, land farming), thermal treatment, chemical treatment, evaporation, recycling, and landfill disposal.

## 3.1 UNDERGROUND INJECTION (EXCLUDING SALT CAVERNS)

Injection into offshore formations can be a feasible alternative for disposal of drilling muds and cuttings, and produced water. Onshore California injection or territorial seas injection must be conducted in compliance with California Division of Oil, Gas, and Geothermal Resources (DOGGR) requirements, and offshore injection must be conducted in compliance with State Land Commission or MMS requirements, which may limit the volume of waste that can be disposed as a result of formation capacity. In addition, not all production formations have the capacity to receive the total volume of produced water that is generated. Therefore, although 100 percent of produced water is being injected at some platforms, not all operations can depend on 100 percent injection because of reservoir characteristics.

Injection of muds and cuttings is geologically more limited and technically more challenging than injection of produced water because particulate matter in muds and cuttings is more likely to clog the well or receiving formations. Injection of drilling fluids and cuttings involves fracturing the receiving formation, which can cause concerns about fracture initiation, fracture extension, fracture boundaries, and fracture capacity. Drill cuttings and associated drilling fluid are slurried with slops, produced water and/or seawater with viscofiers, and inhibitors prior to injection. Often, the mixing of muds and cuttings with produced water or seawater to create a slurry mix is necessary prior to injection but the risks of clogging still exist.

Underground injection in the form of operator owned onshore and offshore disposal wells, enhanced oil recovery wells, and annular injection are currently utilized by some operators who inject from 1 percent to 100 percent of their produced water and no more than 20 percent of drilling muds and/or cuttings.

### Offshore Injection Wells

Injection into offshore formations is technically feasible in certain areas for produced water and limited volumes of WBM, OBM, and cuttings. This option is used by some operators but not all because capacity and flow rates are controlled by reservoir/formation geology. Also, compatibility with the receiving formation is a factor for produced water injection. So, while it may be feasible to install injection treatment and pumping systems for produced water, WMB, and cuttings, economical and geological constraints can and do prohibit/inhibit the feasibility at several platforms. The feasibility of produced water, WBM, and water-based cuttings injection is further evaluated on a platform by platform basis in report sections 6.0 through 11.0.

### Commercial Injection Wells

The only onshore (non-platform related) commercial disposal facility currently utilized for injection by any of the platform operators is Anterra Energy Services (Anterra) located in Ventura, California. Anterra is a DOGGR permitted facility that can accept Class II non-hazardous exploration and production wastes including OBM, WBM, and cuttings. The following are the costs associated with Anterra:

**Table 3-1**
**Summary of Costs for Anterra**

| Waste | Cost * | Daily Intake Limit |
|---|---|---|
| Water-based Drilling Muds | $10.50/bbl | 500-600 bbls/day |
| Oil-based Drilling Muds | $18.50/bbl | |
| Water-based Drill Cuttings | $65.00/ton | 300 tons |
| Oil-based Drill Cuttings | $85.00/ton | |

* Costs exclude transportation to Anterra

Prior to injection, Anterra processes all drilling muds and drill cuttings through a centrifuge to separate the liquid phase from any solids. Upon separation, “clean solids” (non-petroleum impacted solids) are transported to Santa Maria for reuse as daily landfill cover.

"Treatment solids" (petroleum impacted solids) are transported offsite for thermal treatment at Thermal Remediation Systems, Inc. (TRS) in Azusa, California. Significant energy is consumed in thermal separation or thermal desorption processes. Also, there are significant safety hazards and risks associated with these high temperature processes. Final disposition of the thermally treated soil is for reuse as daily cover at the Waste Management, Inc., Azusa Landfill in Azusa, California.

Northstar Energy LTD (Northstar) is also a DOGGR permitted facility that can accept Class II non-hazardous exploration and production wastes including OBM, WBM, and produced water. The Northstar facility is located in the South Belridge Oil Field, approximately 50 miles north of Bakersfield, California. The following are the costs associated with Northstar:

**Table 3-2**
**Summary of Costs for Northstar**

| Waste | Cost * | Daily Intake Limit |
|---|---|---|
| Water-based Drilling Muds up to 3% Solids | $1.00/bbl | |
| Oil-based Drilling Muds 3% and higher solids | $5.00/bbl | 3,400 bbls/day |
| Produced Water | $1/bbl | |

Notes: * Costs exclude transportation to Northstar

Based on available treatment capacity and solid management quality requirements, use of commercial onshore injection wells is technically feasible only for very limited volumes of WBM, OBM, and associated cuttings.

## 3.2 UNDERGROUND INJECTION – SALT CAVERNS

California geologic structure does not include salt domes or the occurrence of bedded salt formations in the quantities and locations that would allow their use for waste disposal. Disposal of produced water, drilling muds, and drill cuttings to salt formations (salt caverns) is not an available alternative in California.

## 3.3 THERMAL TREATMENT

Thermal treatment uses high temperatures (incineration or thermal desorption) to reclaim or destroy hydrocarbon-impacted material. For exploration and production wastes, thermal treatment is an interim process to reduce hydrocarbon content prior to material disposal in a landfill. The technology can be used for the treatment of dewatered OBM and associated cuttings. Southern California commercial thermal treatment facilities include:

- Thermal Remediation Systems (TRS), located in Azusa, County of Los Angeles.

The TRS facility is designed primarily to process solids with a low liquid content. The TRS facility will not take solids with visible liquids, and the water content in the solid waste is required to be below 15 percent. TRS will accept up to 100 bbl of mud per day, and these muds are generally blended with low water content solid waste prior to processing. The cost of processing solids with low water content (less than

15 percent) is $35 per ton and $45 per ton for solids with more than 15 percent water content. The TRS facility is capable of processing 1,500 tons per day of regular solids, and the costs are summarized below.

**Table 3-3**
**Thermal Treatment Costs**

| Origin | Transportation Cost | Treatment Cost |
|---|---|---|
| Oxnard | $20/ton | $35/ton |
| Los Angeles | $11/ton | $35/ton |

The above mentioned costs include landfill disposal. The mud processing capacity of the TRS thermal treatment facility is limited and is not designed to accept mud on a regular basis.

Based on available treatment capacity and solid management quality requirements, thermal treatment is not a feasible option due to the low processing capacity and the inability to process muds or any solids with a high water content.

## 3.4 LANDFILL DISPOSAL OF LIQUID AND SOLID WASTE

Class I landfills are designated for disposal of hazardous wastes. Waste that is defined as “Variance Waste” or “Hazardous, Legal Exception” by Department of Toxic Substances Control (DTSC) and “Designated Waste” as defined by State Water Resources Control Board (SWRCB) requires disposal at Class II landfill. The use of Class III and unclassified landfills is reserved for disposal of non-hazardous solid waste and inert waste.

Disposal of non-hazardous drilling muds and cuttings is technically feasible in Class II landfills. Class II landfills in Southern California that accept exploration and production waste include:

- Clean Harbors (Buttonwillow Facility)
- Kettleman Hills (operated by Waste Management)
- McKittrick (operated by Waste Management)

Disposal of muds and cuttings at the above mentioned landfills requires compliance with the following criteria: 1) the landfill requires that the waste does not contain free liquids, and 2) the waste must be classified as non-hazardous waste. Additional pre-treatment would be required to remove free liquids from drilling fluids in order to meet the no free liquids requirement.

**Table 3-4**
**Disposal Costs at Class II Landfills**

| Facility | Miles from Oxnard[1] | Miles from Los Angeles[1] | Daily Maximum Volumes Mud | Daily Maximum Volumes Cuttings | Disposal Costs for Solids ($/Ton) | Disposal Costs for Liquid |
|---|---|---|---|---|---|---|
| McKittrick (WM) | 107 miles | 167 miles | 3 VAC Loads per Day | 1,100 tons/day | 40 | $65 /ton |
| Kettleman Hills (WM) | 190 miles | 200 miles | Unlimited | Unlimited | 40 | $1 /gallon of water<br>$150 /ton of sludge |
| Buttonwillow (Clean Harbors) | 135 miles | 151 miles | Unlimited | Unlimited | 31 | $1.25 per gallon |

Notes:

Kettleman Hills is located at 35251 Old Skyline Rd in Kettleman City, California

The McKittrick Waste Landfill is located at 56533 Highway 58, West McKittrick, California

The Clean Harbors Landfill is located in Buttonwillow, California.

[1] Oxnard (Pt. Hueneme) and Los Angeles were selected because they are the two main ports for cargo boats servicing the platforms in this study.

The following estimated cost information is for transportation to the Buttonwillow Landfill:

- Vacuum truck transportation costs from Oxnard (Pt. Hueneme) to Buttonwillow Landfill is $700 per load.
- Transport costs for bin delivery (2 bins per truck) from Oxnard (Pt. Hueneme) to Buttonwillow Landfill is $650 per load.
- Vacuum truck transportation costs from Los Angeles to Buttonwillow is $775 per load.
- Transport costs for bin delivery (2 bins per truck) from Los Angeles to Buttonwillow Landfill is $730 per load.

Disposal of non-hazardous drilling muds and cuttings is feasible in Class II landfills and is further evaluated on a platform by platform basis in report sections 6.0 through 11.0.

## 3.5 LANDFARMING AND BIOREMEDIATION

Landfarming and bioremediation use the controlled application of drilling wastes to a soil surface to allow for microorganisms, both naturally occurring and applied, to aid in the degradation of the organic material, primarily hydrocarbon, content. Both methods are associated with land-based exploration and production operations with sufficient acreage to facilitate waste processing activities. Both landfarming and bioremediation are considered an interim process to reduce hydrocarbon content of the waste material prior to onsite reuse or disposal at an approved landfill. There are no commercial disposal operations for drilling waste landfarming and bioremediation within Southern California. Discharge of drilling muds and cuttings to landfarming and bioremediation facilities is not a feasible commercial disposal alternative in California.

## 3.6 EVAPORATION

In semi-arid regions, evaporation has been utilized for disposing of exploration and production wastes. Evaporation would require the use of retention ponds that facilitate an evaporation rate that equals or exceeds the total volume of produced water influent. Evaporation is associated with land-based exploration and production operations with sufficient acreage to facilitate produced water evaporation. There are no commercial disposal operations for produced water evaporation in Southern California. Discharge of produced water to evaporation facilities is not a feasible commercial disposal alternative in California.

## 3.7 EPA-DESIGNATED OCEAN DISPOSAL SITES

WBM and cuttings from offshore drilling operations cannot be disposed at EPA-designated ocean disposal sites for dredged material in southern California, including LA-3 and LA-5. EPA –designated ocean disposal sites are designated for the disposal of clean dredged sediments only. A re-designation procedure that is likely to require an extensive environmental impact assessment study and a formal environmental impact statement (EIS) development would be necessary. The extensive field study and consultations with the public and government agencies could take from 3-5 years at an expense of several million dollars to the proponents makes this approach impractical. Discharge of WBM and cuttings to EPA-designated ocean disposal sites is not a feasible commercial disposal alternative in California.

## 3.8 SUMMARY

Based on the analysis of alternatives conducted above the following discharge alternatives have been identified for disposal of drilling muds and cuttings and produced water resulting from offshore drilling and production activities in Southern California:

- Injection into marine formations – Technically feasible in certain areas for produced water and limited volumes of WBM, OBM, and cuttings. This option is used by some operators but not all because capacity and flow rates are controlled by reservoir/formation geology. Also, water compatibility is a factor for produced water injection. So, while it may be feasible to install an injection treatment and pumping system for produced water, WMB, OBM, and cuttings, economical and geological constraints can and do prohibit/inhibit the feasibility at several platforms. The feasibility of 100 percent produced water, WBM, and water-based cuttings injection is further evaluated on a platform by platform basis in report sections 6.0 through 11.0.

- Injection using onshore commercial disposal wells – Feasible only for limited volumes of water- and oil-based drilling muds and cuttings (less than 600 barrels per day). This is not a technically feasible option for 100% disposal of all the muds and cuttings, especially the large and sometimes rapidly generated volumes of WBM, generated during drilling operations at any one platform. This is also not technically or logistically feasible for the disposal of produced waters because of the limited capacity and the large volumes of produced water that are generated daily.

- Disposal of produced water, drilling muds, and drill cuttings to salt formations (salt caverns) is not an available alternative in California.

- Based on available treatment capacity and solid management quality requirements, thermal treatment is not a feasible option due to the low processing capacity and the inability to process muds or any solids with a high water content.

- Disposal of non-hazardous drilling muds and cuttings is technically feasible in Class II landfills that accept exploration and production waste. The feasibility of 100 percent WBM and water-based cuttings transportation to shore for disposal at a landfill is further evaluated on a platform by platform basis in report sections 6.0 through 11.0.

- Discharge of drilling muds and cuttings to landfarming and bioremediation facilities is not a feasible commercial disposal alternative in California.

- Discharge of produced water to evaporation facilities is not a feasible commercial disposal alternative in California.

- Discharge of WBM and cuttings to EPA-designated ocean disposal sites is not a feasible commercial disposal alternative in California.

# 4.0 REGULATORY CONSTRAINTS ON DISPOSAL ALTERNATIVES

The offshore discharge of oil and gas exploration and production wastes is regulated, with the regulations ranging from total prohibition of discharge to limiting the volume that can be discharged, depending upon the characteristics of the waste. Oil-based drilling fluids and associated drill cuttings are prohibited from being discharged overboard. Water-based drilling fluids and associated drill cuttings are permitted to be discharged, provided the discharge meets permit limitations. Produced water can be discharged, provided the concentrations of regulated constituents in the produced water do not exceed permitted limits and the total volume discharged does not exceed the value permitted for each platform.

Onshore disposal of oil and gas exploration and production wastes is also regulated. When offshore wastes are transported onshore, the physical and chemical characteristics need to be tested to determine their waste classification before being accepted at a landfill facility.

The offshore regulatory requirements for produced water, drilling muds, and drill cuttings cover two main categories: overboard discharge and injection. Regulations for ocean and land-based options that can be used for produced water, drilling muds and cuttings are discussed herein.

## 4.1 REGULATIONS GOVERNING THE OVERBOARD DISCHARGE OF PRODUCED WATER, DRILLING MUDS, AND DRILL CUTTINGS

The Clean Water Act (CWA), enacted in 1972, established the National Pollutant Discharge Elimination System (NPDES) program. As authorized by the Clean Water Act, the NPDES program issues permits to control water pollution by regulating point sources that discharge pollutants into the surface waters of the United States. In general, there are two types of NPDES permits issued: general and individual. Individual permits cover a specific facility and general permits cover multiple facilities within a certain category located in a specific geographical area (Veil et. al, 2004). The U.S. EPA is in charge of implementing the NPDES permit program and may authorize states or tribes to implement parts of the NPDES program within their respective state or tribal jurisdictions. The EPA implements the NPDES permit program in offshore waters under federal jurisdiction. In 1982 the U.S. EPA first issued NPDES General Permit No. CA0110516 covering the offshore waters of California, which applied to discharges from 14 existing platforms (A, B, C, Edith, Eureka, Gilda, Gina, Habitat, Harvest, Henry, Hermosa, Hillhouse, Hidalgo, and Hondo). The remaining nine platforms were covered by eight individual permits. In 2004, the U.S. EPA issued NPDES General Permit CAG280000 (NPDES General Permit) that became effective on December 1, 2004. This permit regulates 22 types of discharges from the existing 22 platforms in federal waters on the Pacific Outer Continental Shelf offshore California.

Within the NPDES program, the discharge of pollutants to receiving waters is typically controlled through numerical effluent limits. Effluent limits identify the pollutants to be monitored and the quantity or concentration of a given pollutant that can be discharged. Effluent limits are derived from the applicable technology-based effluent limitation guidelines (ELGs) and water quality-based standards.

The ELGs are developed on an industry-by-industry basis and represent the greatest pollutant reductions that are economically achievable for an industry sector or portion of the industry (e.g., offshore oil and gas platforms). The ELGs developed for the oil and gas industry include three separate categories: onshore activities, coastal activities, and offshore activities.

## 4.2 PRODUCED WATER

For this report, the primary ELGs of interest for produced water are for the offshore activities. The only applicable ELGs for offshore oil and gas activities were developed for oil and grease. The current oil and grease effluent limits are 42 mg/L daily maximum and 29 mg/L monthly average.

Water quality-based effluent limits in NPDES permits are typically more stringent than ELGs. These are required when technology-based controls may not be stringent enough to ensure that applicable water quality criteria are met. These water quality-based limits (water quality criteria) may be numeric or narrative. Water quality criteria for 26 chemical parameters are specified in the general NPDES General Permit (Table 4-1). The criteria are applied at the edge of the 100-meter mixing zone, after initial dilution with the ambient seawater has occurred for the purposes of the study.

**Table 4-1**
**Water Quality Criteria for Produced Water Reasonable Potential Determination**

| Constituent | Water Quality Criteria (ug/L)[1] |
|---|---|
| Ammonia | 1300/600 |
| Arsenic | 36/8 |
| Cadmium | 8.8/1 |
| Copper | 3.1/3 |
| Cyanide | 1/1 |
| Lead | 8.1/2 |
| Manganese | 100 |
| Mercury | 0.051/0.04 |
| Nickel | 8.2/5 |
| Selenium | 71/15 |
| Silver | 1.9/0.7 |
| Zinc | 81/20 |
| Benzene | 51/5.9 |
| Benzo(a)Anthracene | 0.018 |
| Benzo(a)Pyrene | 0.018 |
| Chrysene | 0.018 |
| Benzo(k)Fluoranthene | 0.018 |
| Benzo(b)Fluoranthene | 0.018 |
| Dibenzo(a,h)Anthracene | 0.018 |
| Chromium VI | 50/2 |
| Phenol | 1,700,000 |
| Toluene | 15,000/85,000 |
| Ethylbenzene | 2,100/4,100 |
| Naphthalene | NA |
| 2-4-Dimethylphenol | 2300 |
| Undissociated Sulfides | 2 |

Note: [1]Where two numbers are given, the first number is the Federal criterion (63 FR 68354, December 10, 1998) and the second is the objective from the California Ocean Plan. For each such parameter, the applicable criterion is the one which proves to be more stringent.

The NPDES General Permit requires facilities to conduct monthly chronic toxicity tests with the larval Red Abalone, *Haliotis Rufescens* (larval development test) and annual screenings with Giant Kelp, *Macrocystis Pyrifera* (germination and germ-tube length test), Topsmelt, *Atherinops Affinis* (survival and growth), and Red Abalone, *Haliotis Rufescens* (larval development test). These annual screenings are rotated each year to insure that measurements are collected during the different seasonal periods. A reduction in the testing frequency from monthly to quarterly may be requested if permit conditions are met after one year of testing.

The NPDES General Permit also set limits on the maximum allowable annual volume of produced water discharges from each platform. Table 4-2 shows the annual amount of produced water that is allowed to be discharged by each platform included in the feasibility study.

**Table 4-2**
**Maximum Annual Allowable Produced Water Discharges**

| Platform | Maximum Annual Allowable Produced Water Discharges (bbls) |
|---|---|
| Ellen/Elly & Eureka | 10,950,000 |
| Gail | 4,380,000 |
| Grace | 2,190,000 |
| Harmony, Heritage, Hondo | 33,762,500 |
| Harvest | 32,850,000 |
| Hermosa | 40,250,000 |
| Hidalgo | 18,250,000 |
| Hogan | 13,900,000 |
| Houchin | 13,900,000 |
| Irene | 55,845,000 |

Facilities are required to report the results of their self-monitoring activities to the EPA to ensure that they are in compliance with the NPDES General Permit limits. The permit specifies the frequency for monitoring, chemicals to be analyzed, locations for sampling, and laboratory procedures. Discharge monitoring reports (DMRs) are required to be sent to the EPA on a periodic basis as specified in the permit. The reporting frequency is on a quarterly basis. NPDES General Permit provides the specific details on the reporting requirements for the different monitoring activities. Periodically, the EPA may visit the platform to ensure that the facility is in compliance with the NPDES General Permit requirements. Failure to comply with the NPDES General Permit can result in fines or revocation of the permit.

Some of the platforms use pipelines to transport produced water to shore for treatment. In addition to the above regulations pertaining to waste disposal, there are new Minerals Management Service (MMS) regulations that apply to pipelines constructed in near-shore or offshore areas. These regulations cover three types of surveys that need to be conducted prior to construction of pipelines or new platforms on the ocean floor. These surveys include: biological surveys (NTL No. 06-P02), archaeological surveys (NTL No. 06-P03), and shallow hazards surveys (NTL No. 06-P01).

## 4.3 DRILLING MUDS AND CUTTINGS

The NPDES General Permit for offshore California waters does not allow discharge of non-aqueous drilling fluids, such as SBM, OBM, and associated cuttings. In addition, no diesel oil or free oil can be present in any drilling muds or cuttings that are discharged to the ocean. A static sheen test is required to demonstrate that the waste material to be discharged is free of oil; this test should be conducted at least weekly and before a bulk discharge. If a known hydrocarbon zone is being drilled, the static sheen test should be conducted on a daily basis. The permit requires daily measurement of the volume of cuttings and other drilling fluid discharged per well and the number of days of such discharges. In addition, effluent limits are specified for cadmium and mercury in barite. The limit for cadmium is 3 mg/kg for most platforms, and 2 mg/kg for Platforms Harmony and Heritage; the limit for mercury is

1 mg/kg for all platforms. A chemical inventory of the drilling mud used must also be prepared.

The NPDES General Permit specifies that toxicity tests have to be conducted on drilling fluids and cuttings using *Mysidopsis Bahia*. The drilling mud to be used is required to be collected after at least 80 percent of the actual permitted well footage has been reached for each interval where a given type of mud is used. The minimum 96-hour LC50 value of discharged waste is 3 percent of the Suspended Particulate Phase (SPP) by volume. The procedures are described in “Drilling Fluids Toxicity Tests” Appendix 2 to Subpart A of 40 CFR Part 435. The NPDES General Permit requires that toxicity results be included in the Discharge Monitoring Reports (DMR) for each platform.

A drilling fluid inventory is required for the DMR that provides the following information:

- Base (generic) drilling fluid type.
- Product name and total volume or weight of each constituent.
- Total volume of drilling fluid discharged.
- Number of days of discharge.
- Estimated maximum concentration of each constituent, if no toxicity test was conducted on that particular drilling fluid.

The eight generic drilling fluids are listed in Table 4-3. Separate toxicity tests are not needed if these mud types are used except in the following two cases: (1) if additives are added to the mud types and the data demonstrates that the 96-hour LC50 value of the resulting fluid is less than 100,000 ppm for the suspended particulate phase; or (2) if toxicity data for the fluid or the additives has an overall toxicity limit less than 30,000 ppm. All water-based drilling fluids used by those operators that have conducted drilling activities are based on one of the eight generic mud types.

## Table 4-3
## Types of Generic Drilling Muds

| Mud Number | Name | Components | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | KCl | Starch | Cellulose Polymer | XC Polymer | Acrylic Polymer | Drilled Solids | Caustic | Attapulgite or Bentonite | Ligno-sulfonate | Lignite | Barite | Soda Ash/ Na Bicarbonate | Lime | Seawater | Freshwater |
| 1 | Seawater/ Potassium/ Polymer Mud | 50 | 12 | 5 | 2 | | 100 | 3 | | | | | | | | |
| 2 | Seawater/ Lignosulfonate Mud | | | 5 | | | 100 | 4 | 50 | 15 | 10 | 450 | 2 | | as needed | |
| 3 | Lime Mud | | | | | | 100 | 5 | 50 | 15 | 10 | 180 | 2 | 20 | | as needed |
| 4 | Nondispersed Mud | | | | | 2 | 70 | | 15 | | | 180 | | | | as needed |
| 5 | Spud Mud | | | 2 | | | 100 | 3 | 50 | | | 50 | 2 | 2 | as needed | |
| 6 | Seawater Gel Mud | | | 2 | | | 100 | 3 | 50 | | | 50 | 2 | 2 | as needed | |
| 7 | Lightly Treated Lignosulfonate Mud | | | 2 | | | 100 | 3 | 50 | 6 | 4 | 180 | 2 | 2 | 1:1 ratio | 1:1 ratio |
| 8 | Lignosulfonate Freshwater Mud | | | 2 | | | 100 | 5 | 5 | 15 | 10 | 450 | 2 | 2 | as needed | as needed |

Notes: Types of Generic Muds where toxicity tests are not needed (NPDES General Permit CAG280000).
Component values are in pounds per barrel.

In addition to toxicity limits on the drilling fluids, there are maximum allowable discharge volumes for WBM and cuttings from each platform. These limits are provided in Table 4-4 for those platforms that remain in operation or platforms that are expected to begin drilling within the next three years.

**Table 4-4**
**Maximum Discharge Volumes by Platform for WBM and Cuttings (bbls)**

| Platform | Cuttings | WBM |
|---|---|---|
| Ellen/Elly | 18,150 | 49,950 |
| Gail | 28,700 | 49,500 |
| Grace | 28,700 | 49,500 |
| Harmony | 40,000 | 200,000 |
| Harvest | 12,000 | 53,500 |
| Heritage | 40,000 | 200,000 |
| Hermosa | 11,250 | 41,000 |
| Hidalgo | 6,000 | 23,000 |
| Hogan | 34,000 | 118,000 |
| Hondo | 40,000 | 200,000 |
| Houchin | 34,000 | 118,000 |
| Irene | 30,000 | 105,000 |

Notes: Amounts are from NPDES General Permit CAG280000
Only existing platforms or those expected to begin drilling in the next three years are listed.

## 4.4 REGULATIONS GOVERNING THE INJECTION OF PRODUCED WATER, DRILLING MUDS, AND DRILL CUTTINGS

Injection of produced water can be a viable option for the disposal of produced water when the water chemistry and reservoir geology are suitable. Some platforms are already using this technology to dispose of at least a portion of their produced water into depleted wells at the platform. As part of the Safe Drinking Water Act of 1974, the EPA was given the authority to develop Underground Injection Control (UIC) regulations. The primary goal of the UIC program is to protect underground sources of drinking water. The UIC program classifies injection wells into five different categories. Class II wells are the category of underground injection wells associated with oil and gas production and the ones that would be used for the injection of produced water, if onshore.

Federal jurisdiction of the submerged lands on the Outer Continental Shelf was established by the Outer Continental Shelf Lands Act (OCSLA). There are no underground sources of drinking water below the OCS, so the regulations established by the UIC program do not apply to the injection of produced water at the platforms. The only cases where the regulations of the UIC program would apply to the disposal of produced water from the platforms would be if the produced water was piped to shore and then injected on land as a disposal method. The Minerals Management Service (MMS) is the agency in charge of managing the oil and gas activities on the OCS. The MMS handles each application for underground waste disposal on a case-by-case basis.

## 4.5 Regulations Governing Onshore Disposal of Drilling Muds and Drill Cuttings at a Landfill

Oil and gas exploration and production (E&P) wastes, including produced water, drilling muds, and drill cuttings, were conditionally exempted from the hazardous waste management requirements of Subtitle C of the Resource Conservation and Recovery Act (RCRA) enacted by Congress in 1980. At that time, the U.S. Environmental Protection Agency (EPA) was directed to study these wastes and develop a report for Congress on the status of their management. In 1988, the EPA published its regulatory determination in the Federal Register at 53 FR 25447, which determined that produced water, drilling muds, and drill cuttings should be exempt from regulation under Subtitle C of RCRA and deemed a non-hazardous waste. However, this exemption did not preclude these wastes from control under other federal and state regulations, including oil and gas conservation programs and some hazardous waste programs (U.S. EPA, 2002). California did not concur with the full non-hazardous exemption. Instead, the state agreed that oil and gas (E&P) wastes would not be classified as hazardous if the only reason was that the Toxicity Characteristic Leaching Procedure (TCLP) limits were exceeded. However, if the wastes met any other criteria for hazardous wastes such as ignitability, corrosivity, reactivity, or toxicity, the waste is classified as a hazardous waste. If offshore wastes are transported onshore, the physical and chemical characteristics need to be tested to determine their waste classification prior to disposal.

Drilling muds and cuttings can be transported to shore by supply vessel or barging, dewatered, and then transported by truck for disposal in Class II landfills. However, if the wastes exhibit one of the other hazardous waste characteristics such as ignitability, corrosivity, or toxicity by a means other than the TCLP leachate tests, then the wastes are classified as hazardous based on California regulations. In that case, the wastes would require disposal in a Class I landfill.

Two landfills in Kern County California that accept water or oil-based drilling muds and cuttings were identified in a recent report on availability of offsite disposal options (Puder and Veil, 2006). Seven platforms are currently using one of these landfills for disposal of OBM and cuttings.

## 4.6 Regulations Governing Disposal of Drilling Muds and Cuttings at EPA-Designated Ocean Disposal Sites LA-2 and LA-3

Material that is determined to be suitable for ocean disposal can be disposed at an EPA-designated ocean disposal site. The following regulations apply to ocean disposal in California.

- The Clean Water Act (CWA) – Section 401 and Section 404
- Marine Protection, Research and Sanctuaries Act (MPRSA) - Section 103
- Rivers and Harbors Act (RHA) - Section 10
- Porter-Cologne Act

- California Coastal Act
- National Environmental Policy Act (NEPA)
- California Environmental Quality Act (CEQA)

The USACE (U.S. Army Corps of Engineers) and U.S. EPA determine the suitability of dredged material proposed for ocean disposal under criteria defined in the regulations and regulate the disposal of sediment at designated ocean disposal sites. Two ocean disposal sites are located in southern California. These sites are designated as LA-2 which is located 5.9 miles offshore of Los Angeles County, and LA-3 which is located 5.2 miles offshore of Orange County.

Disposal sites LA-3 and LA-5 are designated for dredged material only. A re-designation process would be required to consider the suitability of water-based drilling fluids and cuttings to be disposed of at an existing designated dredged material disposal site, or at any other location, including the THUMS site off Los Angeles, which was used occasionally for drilling wastes disposal over 25 years ago. The re-designation process would be an Environmental Impact Statement-level study with the US Army Corps of Engineers and the US EPA as lead agencies. Extensive modeling, environmental and oceanographic studies and several millions of dollars provided by the study proponents would be required over a three- to five-year effort. The outcome of the effort could not be guaranteed to be successful. Many operational aspects of WBM and cuttings disposal could also present insurmountable problems for disposal management and monitoring.

# 5.0 SECONDARY ENVIRONMENTAL IMPACTS

This section discusses the potential environmental impacts associated with the alternatives disposal options. Under some circumstances, the secondary effects can result in a greater adverse impact to the environment than the impacts created directly by discharging to the ocean.

### Primary Environmental Impacts

Every waste disposal activity creates environmental impacts. For the overboard disposal of drilling muds and cuttings and produced water, the obvious primary impacts are directly related to the discharges of the wastes themselves. Drilling muds and cuttings, although widely dispersed as they fall through the water column have the potential to create local and temporary impacts to the water column. Once the discharge reaches the seafloor, physical impacts such as accumulation of material, changes in grain size distribution and smothering of benthic communities can occur, although the existing benthic environment has been affected already, due to the presence of the platform. Chemical impacts to the benthic community are unlikely because the drilling wastes that are permitted to be discharged exhibit low or no toxicity.

For the overboard discharge of treated produced water, the obvious primary impacts are directly related to the produced water and its constituents as the discharge plume is diluted within the 100-meter radius zone of initial dilution (mixing zone). Physical impacts from changes in temperature or density occur only within the near-field mixing zone during the period of dilution. By the time the produced water plume reaches the edge of the mixing zone, it has been diluted with the receiving water generally by 1,000 times or more. Chemical impacts within the water columns are similarly localized. The NPDES permit requirements restricts the concentrations of identified pollutants that can be discharged in the produced water to levels such that, at the edge of the mixing zone, the pollutant concentrations are less than the water quality criteria required by the Clean Water Act.

### Secondary Environmental Impacts

There are secondary environmental impacts related to the overboard discharge of produced water and drilling muds and cuttings. The major sources of impacts are the emissions to the atmosphere from the treatment and discharge equipment. For example, the air emissions from the generators or motors used to power the discharge pumps, the mud and cuttings separation equipment, and the produced water treatment equipment.

There are also secondary environmental impacts related to the alternatives to overboard discharge. The significant secondary environmental impacts associated with transportation are air emissions, accidental releases, and socio-economic effects. Transporting the wastes to shore must be accomplished by pumping through a pipeline or by transport via supply vessel to shore and then by truck to the disposal site. Pump and motor exhaust emissions are unavoidable and can be a source of substantial secondary environmental. Accidental spills can usually be avoided through appropriate handling procedures but they do occur infrequently and they have the potential to create significant environmental impacts. Increased traffic congestion and safety risks due to transportation are also factors.

Injection of produced water into the reservoirs will involve additional secondary impacts compared to overboard discharge because the pumping capacity must be greater to overcome formation pressures.

## 5.1 SECONDARY IMPACTS FROM PRODUCED WATER HANDLING METHODS

Alternatives to discharging produced water overboard at the production platforms include:

- Transport to shore-based treatment via pipeline followed by discharge to ocean.
- Injection into oil or gas producing formations or other formations.

Potential secondary impacts from using these methods are listed in Table 5-1. The significant impacts are air emissions from transportation by boat or trucks from the treatment and handling equipment. Shore-based transport or treatment is expected to have increased air emissions that are especially significant in populated areas. The counties involved in the offshore drilling, Santa Barbara and Ventura, regulate air emissions and set limits on allowable emissions from vessels, diesel-powered vehicles and other equipment.

Pumping the fluid to shore via pipelines requires power. Power is supplied to the pumps and other equipment from natural gas-fired turbines, using production gas from the underlying reservoir, or diesel that is transported to the platform, or from the electricity grid, via a submarine transmission cable.

Other environmental impacts could result from spills or leaks of untreated produced water to the ocean, coastal areas, or shoreline. Earthquakes, undersea landslides, or boat anchors can rupture or cause a leak in a pipeline. The primary effect of a spill to marine waters would be potential toxicity from the oil and grease and organic compounds such as benzene and phenol. Toxicity tests on produced water show that acute toxicity was relatively low, although some chronic effects in marine organisms have been seen in laboratory and field tests (Holdway, 2002).

**Table 5-1**
**Potential Secondary Impacts of Produced Water Handling Methods**

| Handling Methods | Secondary Impacts |
|---|---|
| **Transportation** | |
| Subsea Pipeline | •Risk of spills (waste material)<br>•Air emissions from pumps on platform<br>•Air emissions from treatment equipment onshore<br>•Air emissions from pumps on shore |
| Vessels and Trucks | •Risk of spills (waste material)<br>•Air emissions from vessels and trucks<br>•Air emissions from cranes<br>•Air emissions from pumps on platform<br>•Air emissions from treatment equipment onshore<br>•Increased traffic and associated safety issues |
| **Disposal** | |
| Offshore Injection | •Air emissions from equipment<br>•Extra equipment and labor requirements (on the platform)<br>•May require pre-treatment prior to injection<br>•Increased power and fuel usage |
| Onshore Injection | •Air emissions from injection equipment<br>•Increased power usage<br>•Increased chance of groundwater contamination from on-shore disposal |

## 5.2 SECONDARY IMPACTS FROM DRILLING MUDS AND CUTTINGS HANDLING METHODS

Alternatives to the overboard discharge of WBM and cuttings include:

- Transport to shore-based disposal or recycling facility.
- Injection into formation from platform.
- Transport to and injection into onshore injection well.

Potential secondary environmental impacts from using these methods are listed in Table 5-2. Each option can result in increases in air emissions from transportation by supply vessel or trucks and to a lesser extent from the injection pumps. Air emissions from the shore-based transport will have a greater chance of contributing to air quality effects on populated areas than the emissions from supply vessels. The counties involved in the offshore drilling, Santa Barbara and Ventura, regulate air emissions and set limits on allowable emissions from diesel-powered vessels and other equipment.

Other potential environmental impacts from transporting drilling wastes to shore include spills to the ocean, coastal areas, or shoreline from supply vessels due to possible upsets while loading, unloading, or transporting, or by possible collisions with other supply vessels and exposure to storms.

**Table 5-2**
**Secondary Impacts for Drilling Muds and Cuttings Handling Methods**

| Handling Methods | Secondary Impacts |
|---|---|
| **Transportation** | |
| Supply Vessel | •Air emissions from marine vessels due to diesel fuel combustion<br>•Extra equipment and labor requirements (onshore and offshore)<br>•Increased fuel usage<br>•Increased marine traffic on sea and in port<br>•Increased risk of spills (waste material and fuel from marine vessels)<br>•Increased exposure to aromatic hydrocarbons from handling wastes<br>•Safety hazards associated with loading, transporting, and unloading boats<br>•Weather may inhibit transport of wastes |
| Trucks Onshore | •Air emissions from diesel vehicles<br>•Extra equipment and labor requirements (onshore)<br>•Increased fuel usage<br>•Increased traffic in port and on highways to disposal sites<br>•Increased risk of spills (waste material and fuel from trucks)<br>•Increased exposure to aromatic hydrocarbons from handling wastes<br>•Safety hazards from loading, transporting,, and unloading trucks |
| **Disposal** | |
| Offshore Injection (more common for drilling muds than cuttings) | •Extra equipment and labor requirements (on the platform)<br>•Drill cuttings may require grinding prior to injection (pre-treatment)<br>•Increased power and fuel usage<br>•Increased air pollution due to large power requirements<br>•Possible breach to seafloor due to fracture propagation |
| Onshore Injection (unlikely due to additional regulations and added expense) | •Air emissions from injection equipment and transportation vehicles<br>•High costs<br>•Increased power usage<br>•Increased chance of drinking water contamination from on-shore disposal<br>•Fuel usage by transportation equipment onshore |
| Landfilling | •Air emissions from landfill equipment and transportation vehicles<br>•Increased fuel usage from transportation vehicles and landfill equipment<br>•Increased risk of spills due to transfer of waste materials<br>•Increased chance of surface/groundwater contamination from on-shore disposal, unless mixed with cement prior to disposal<br>•Requires appropriate long-term monitoring |

Injection of drilling fluids is practiced by several platforms for water and small percentages of WBM and cuttings. If a suitable geologic formation is available with the required capacity and porosity, this method avoids potential impacts from transport and from discharge of exploration and production wastes on the marine environment. Spills of drilling wastes could occur from a break in the below water part of the injection system, but this is unlikely. While injection is applicable to both water and oil-based drilling fluids, adequate capacity may not be available at all the platforms. In fact, the projected disposal via injection of these exploration and production wastes in the next five years is only 5 to 25 percent of the total volume of wastes generated.

Potential secondary environmental impacts from disposal of drilling WBM and cuttings in landfills include air emissions from unloading and handling operations, generation of methane gas, and leaching of soluble compounds to groundwater or drinking water. Landfills can be designed to minimize their risk of these impacts, but at additional cost.

# 6.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS – AERA ENERGY LLC

## 6.1 PLATFORMS ELLY/ELLEN

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Elly/Ellen. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water, water-based mud (WBM), and water-based cuttings are described.

### 6.1.1 Current practices

#### *6.1.1.a Produced Water*

Produced water for 2000 through 2006 (approximately 3.5 million bbls per year) was injected into the reservoir. The current operator indicated that future volumes of produced water may increase as Platforms Elly/Ellen are being sold to a separate oil production operator that may also plan further development of the reservoir.

Produced water was discharged to the ocean only if an upset condition occurred. The operator did not provide cost estimates for the previous or future injection and discharge of produced water for Platforms Elly/Ellen.

#### *6.1.1.b Drilling Muds and Cuttings*

Platforms Elly/Ellen did not generate drilling muds or cuttings from 2000 to 2006. Information regarding future drilling operations and mud and cuttings volumes were not available because of the impending sale of the platform. The operator who is in the process of purchasing and taking over platform operations may plan additional drilling for the future, but specific information regarding the future use, disposal, injection, or discharge of muds and cuttings is not available at this time.

### 6.1.2 Alternatives to Discharge

#### *6.1.2.a Produced Water*

All produced water at Platforms Elly/Ellen was injected from 2000 through 2006 except during any infrequent and brief upset conditions when the injection system was inoperable. An average of approximately 3.5 million bbls per year was injected. Produced water was discharged to the ocean only if an upset condition occurred. The operator indicates that it is important to the production operation that ocean discharge be available in the case of a production upset condition, a maintenance event, or if the injection system failed. If discharge of produced water to the ocean was prohibited, production operations would be shut-in (stopped) if the injection system was being maintained, repaired, or otherwise not in operation. The current NPDES General Permit allows 10,950,000 bbls of produced water to be discharged annually.

Information regarding estimated produced water volumes for 2007 through 2010 is expected to remain the same or increase. The ownership and operation of the platform is currently in the process of being transferred to another operator. It is likely that produced water generation might increase if additional development and/or drilling results in additional oil and gas production.

Injection of produced water back into the hydrocarbon formation has been identified as the only potentially feasible alternative to the overboard discharge of produced water.

**Technological factors:** Injection technology is currently in use on Platforms Elly/Ellen to dispose of 100 percent of the produced water generated. If projected 2007 through 2010 produced water volumes were increased, as the operator indicated was probable, the capacity of the injection equipment may need to be increased. This is yet to be determined by the new owner/operator. If additional deck space needs to be fabricated to accommodate the injection and/or storage equipment, a structural study would be required to determine if the platform can safely support such a deck extension. Platform power is supplied by generators; the platform is 9 miles offshore and has no access to electric power utilities. The operator incurs large quarterly costs to remain in compliance with SCAQMD RECLAIM Trading Credits (RTC) required for NOx emissions from onboard power generation. Any additional power demand (such as required by additional pumps) will require the operator to purchase additional SCAQMD RTCs, which are currently very expensive and may become more restrictive, costly, and possibly unavailable in the future.

The geology of the production formations is suitable for injection of produced water generation rates from 2000 to 2006. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. Field testing and reservoir modeling may be necessary before the technical feasibility of injection of any additional volumes of produced water could be determined.

**Environmental factors:** Additional power would be required to run the necessary water treatment equipment and injection pumps to accommodate any increase in the volume of produced water treated in the system. The platform power is supplied by onboard generators using produced natural gas and by diesel generators. The diesel generators are used to supplement the gas generators because the volume of natural gas available for power generation is declining. If additional volumes of produced water are generated in the future, diesel fuel will have to be transported from shore to power the injection pumps, resulting in increased air emissions compared to the current operating conditions.

Current operations at Platforms Elly/Ellen do not discharge produced water to the ocean except during an upset condition. If overboard discharge of produced water was prohibited, production operations would be shut-in (stopped) whenever the injection system was not in operation. While no overboard discharge has occurred in the past seven years, downtime for system maintenance and/or failure must be anticipated and planned for.

**Economic factors:** Significant capital and operating costs would be necessary if expansion of the current water injection technology was needed. It is unknown if structural modifications and additional pumps and equipment to inject produced water at Platforms Elly/Ellen are required because of the lack of information available from the current and the future operator; exact costs of such equipment, if any, are unknown.

**Social factors:** Public response to total injection of produced water is likely to be neutral because while a perceived environmental impact to ocean water quality is being reduced, the impact on air quality and RTC demand will be negative. If expansion of injection technology is required, construction would be on the platform and mostly out of the view of the public,. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, and increased air emissions in support of construction activities)..

Offshore injection is regulated by MMS. Regulatory issues are not expected to prohibit injection of produced water because it is a common practice throughout the industry and is currently being conducted at Platforms Elly/Ellen. Injecting produced water is required to maintain reservoir pressure.

The mixed positive and negative perceived environmental impacts, increased air emissions, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** Since data for the future volumes of produced water to be injected at Platforms Elly/Ellen could not be provided by the operator, it cannot be determined if additional injection equipment would be required and it is not possible to determine the time required, if any, that may be necessary to engineer, permit, procure, and install the injection equipment.

*Conclusion*

Continued injection of 100 percent (less a small volume of upset condition discharge) of the produced water generated at Platforms Elly/Ellen is assessed as feasible, providing future volumes do not exceed the treatment and injection pumping capacity available on board.

#### *6.1.2.b Drilling Muds & Cuttings*

Platforms Elly/Ellen did not generate drilling muds or cuttings from 2000 to 2006. Information regarding future drilling operations and mud and cuttings volumes were not available. Platforms Elly/Ellen and Eureka are in the process of ownership/operator transfer who is anticipated to drill additional oil wells. Information regarding the use, disposal, injection, or discharge of muds and cuttings are not available.

Injection of WBM and cuttings by fracture into technically acceptable formations and transporting to shore for disposal in a landfill have been identified as potentially feasible alternatives to the overboard discharge of WBM and cuttings.

##### *6.1.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings.

Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost.

**Technological factors:** The technology is in use on other platforms in the area. Injection equipment is readily available to purchase. Injection of produced water is currently conducted at Platforms Elly/Ellen. However, the injectivity of WBM and cuttings has not been engineered, tested or proven and insufficient information on estimated future drilling activities has been provided to ascertain if injection is a feasible alternative to overboard discharge.

**Environmental factors:** Injection of all WBM and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994). Most importantly, the negative air quality impact of increased fuel/energy usage to power such an injection system would likely significantly outweigh any water quality benefit.

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the General NPDES permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil or oil-based or synthetic-based fluids or toxic additives. In addition, drilling mud bioassays are required to be conducted for each mud system. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are prevented from being discharged to the ocean.

The technological feasibility, in terms of reservoir capability and platform infrastructure adequacy or tolerance is not completely known because engineering studies to support such feasibility analysis have not been performed on this platform in recent years. No drilling has been performed on this platform since 1999. The current operator has no plans for expanding drilling or development. However, the facilities are in the process of being transferred to another operator whose plans for future development are not known.

Secondary environmental impacts may result from the additional power requirements to run the additional injection equipment. The platform power is supplied by onboard natural gas and diesel fuel generators, resulting in increased air emissions from operation of pumps needed to inject drilling muds and cuttings.

The increase in air emissions to inject WBM and cuttings does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The potential increase in air emissions renders the environmental factor to drilling muds and cuttings injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing from WBM and cuttings discharge to injection. The operator did not provide a screening level cost estimate to increase the deck space or for the purchase and installation of the equipment necessary for an injection system. The capital and operating costs are anticipated to be significant and make this option uneconomical relative to the current (pre-1999) practice of overboard discharge.

**Social factors:** Public response to total injection of drilling muds and cuttings is likely to be positive because a perceived environmental impact is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also, public response to increased air emissions from injection operations is likely to be negative.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as MMS approval and SCAQMD permitting) renders the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping required for injection are readily available for purchase. If required, the time needed to engineer, fabricate, and install additional deck space, including permitting, equipment and material procurement, construction, installation, and testing, could range from 24 to 48 months. The feasibility of converting to WBM and cuttings injection is uncertain because of the uncertainty associated with the change in ownership of the platforms and their production plans.

*Conclusion*

Injection of WBM and cuttings that might be discharged overboard at Platforms Elly/Ellen has been assessed for feasibility as an alternative disposal method. The technological feasibility, in terms of reservoir capability and platform infrastructure adequacy is not completely known. The environmental impacts in terms of increased energy use may be substantial, resulting in an uncertain feasibility of injection of all WBM and cuttings if the volume generated is substantial. Potential increases in capital and operating costs make the injection of all WBM and cuttings economically not feasible for the operator when compared to discharge overboard. The negative environmental impacts and regulatory approval considerations renders the social factor to WBM and cuttings injection as not feasible. The feasibility of converting to WBM and cuttings injection is uncertain because of the uncertainty associated with the change in ownership of the platforms and their production plans.

*6.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from other platforms to shore for treatment, recycling, or disposal. Platforms Elly/Ellen did not generate drilling muds or cuttings from 2000 to 2006. Information regarding future drilling operations and mud and cuttings volumes were not available because Platforms Elly/Ellen are under purchase evaluation by another operator that is anticipated to drill additional oil wells. The current operator states that information regarding the future planned use, disposal, injection, or discharge of muds and cuttings is currently not available, due to the current transition of ownership and platform operation.

**Technological factors:** A deck extension may be necessary to provide space for the cuttings boxes required for the transport of mud and cuttings should more wells be developed. A structural study may be required to determine if the platform can safely support such a deck extension. The estimated cost for this deck extension is $2 million.

There are no technological limits to transporting drilling muds to shore. The muds and cuttings can be transported in cuttings boxes, each holding 23 barrels of mud. One supply boat can carry 35 boxes, equivalent to 805 barrels per trip. While large volumes may be transported more efficiently by barge, the use of barges is not considered a viable option due to air permit restrictions. Additional reasons include safety concerns around mooring the barge to the platform and the ability of the barge to safely remain on station during drilling operations occurring under adverse weather conditions.

Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill or onshore injection well would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 6.1.2.b.i; Environmental factors).

In addition, the incremental secondary impacts from air emissions could be significant, depending upon the volume of mud and cuttings generated and thus the number of vessel trips required to transport the material to shore.

The secondary impacts from air emissions may be significant. Emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks.

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

Secondary impacts to air quality might outweigh the environmental benefit of ceasing discharge at the platform, an area that has been disturbed by the platform jacket installation, and more than 20 years of drill cuttings accumulations. This disposal alternative can be classified as being of uncertain feasibility because of the lack of knowledge about future development plans for the facility.

**Economic factors:** There is insufficient information available on the future development plans to assess the economic feasibility of transporting all future WBM and cuttings to shore for disposal.

**Social factors:** Public response to expanded development at Platforms Ellen/Elly cannot be predicted without more information about the possible development plans. The increases in supply vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be mixed as the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, additional supply vessel traffic, increased truck traffic, and depletion of licensed disposal site capacity. The feasibility based on social factors cannot be assessed.

**Time factor:** Insufficient information is available at this time to determine if the time required to establish this alterative is feasible or not feasible.

*Conclusion*

The feasibility of transporting all WBM and cuttings to shore for disposal is unknown because of the uncertainties associated with future production plans at the platforms. Currently no drilling is occurring and no WBM and cuttings have been produced for several years. The current operator has no plans for expanding development. However, the ownership and operations of the facilities are being transferred to another operator whose plans for future development are not known.

## 6.2 PLATFORM EUREKA

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Eureka. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water, WBM (and OBM if used), and associated cuttings are described.

### 6.2.1 Current practices

#### *6.2.1.a Produced Water*

Platform Eureka is currently idle with minimal gas production and has not produced oil (or water) for at least ten years. The operator did not provide cost estimates for the previous or future injection and discharge of produced water for Platform Eureka. Information regarding future produced water volumes projected for 2007 through 2010 was not provided by the operator. Platform Eureka is currently in the process of being purchased by another oil production operator that is anticipated to reestablish oil production operations; however, no development plans are available.

#### *6.2.1.b Drilling Muds and Cuttings*

Platform Eureka did not generate drilling muds or cuttings for over ten years. Information regarding future drilling operations and volumes of mud and cuttings was not available because of the impending sale of the platform. Information regarding the use, disposal, injection, or discharge of muds and cuttings was also not available.

### 6.2.2 Alternatives to Discharge

#### *6.2.2.a Produced Water*

No discharges have occurred at Platform Eureka for over ten years. No plans for future development of the platform are available because of the potential sale of the facility to another operator. Therefore, a meaningful determination of the feasibility of alternative methods to overboard discharge of produced water that may be generated in the future at unknown volumes is not possible. It will be necessary to wait until the acquisition of the platforms by a new operator is competed and the new operator’s development plans are finalized before a feasibility assessment can be conducted. If the purchase and acquisition does not proceed, it will be necessary to wait until the current operator reviews their development plan before an assessment can be made.

#### *6.2.2.b Drilling Muds & Cuttings*

The same constraints as described above for assessing the feasibility of alternatives to the discharge of produced water from Platform Eureka apply to assessing the feasibility of alternatives to the discharge of WBM and cuttings. A meaningful assessment cannot be made because no WBM and cuttings have been discharged and future plans are unknown at this time. The feasibility assessment cannot be conducted for any alternative.

# 7.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS – ARGUELLO INC.

## 7.1 PLATFORM HARVEST

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Harvest. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 7.1.1 Current Practices

#### *7.1.1.a Produced Water*

The average annual volume of produced water generated at Platform Harvest for 2000 through 2006 was 9.4 million bbls, with a minimum of 2.8 million bbls in 2000 and a maximum volume of 14.1 million bbls in 2005. The operator has forecast the produced water volume will almost double to an annual average of 17.9 million bbls for 2007 through 2010 and reaching a maximum one-year volume of 20.5 million bbls in 2010 (Table 7-1). The maximum allowable discharge under the NPDES General Permit is 32.85 million bbls per year. Less than one percent of the produced water is injected; the bulk of the volume is discharged overboard after treatment.

The formation fluid from Platform Harvest undergoes 3-phase separation on the platform which separates the gas, oil and water. The oil shipped to Platform Hermosa is merchantable (i.e. <3% basic sediment and water) where it is combined with merchantable oil from Platform Hidalgo and Platform Hermosa and piped to the Gaviota Oil Heating facility for re-heating and sale. The separated produced water is treated on Platform Harvest by being passed through a series of oil-water coalescers and an induced gas flotation vessel to reduce the oil content further before the water is discharged overboard via a skim-pile vessel. The small percentage of produced water that cannot meet the NPDES General Permit discharge water quality requirements is injected.

**Table 7-1**
**Platform Harvest Produced Water Past (2000-2006) and Forecast (2007-2010) Discharges and Costs**

| | 2000-2006 | | | | 2007-2010 | | | |
|---|---|---|---|---|---|---|---|---|
| **Volume of Produced Water (bbl x 1,000)** | **Min** | **Max** | **Annual Average** | **Total for Period** | **Min** | **Max** | **Annual Average** | **Total for Period** |
| Generated | 2,809 | 14,083 | 9,377 | 65,643 | 15,429 | 20,536 | 17,902 | 71,609 |
| Discharged | 2,795 | 14,045 | 9,315 | 65,207 | 15,398 | 20,494 | 17,865 | 71,461 |
| Injected | 12 | 215 | 62 | 436 | 32 | 42 | 37 | 148 |
| % injected | < 1% | < 1% | < 1% | < 1% | < 1% | < 1% | < 1% | < 1% |
| Cost ($'000s) | | | | | | | | |
| Discharged | 839 | 4,214 | 2,795 | 19,562 | 4,619 | 6,148 | 5,360 | 21,438 |
| Injected | 4 | 65 | 19 | 131 | 10 | 13 | 11 | 44 |
| Total | 842 | 4,278 | 2,813 | 19,693 | 4,629 | 6,161 | 5,371 | 21,483 |
| Cost $/bbl | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

Note: NPDES General Permit maximum annual allowable produced water discharge is 32.85 million bbls per year.

Platform Harvest produced water treatment and discharge costs are estimated by the operator at $0.30 per barrel (Table 7-1). This includes the costs for treatment system chemicals, required analytical testing, pumping operations, and maintenance costs. The cost to inject the small volume of produced water is also stated at $0.30 per barrel. Forecast costs for 2007 through 2010 are anticipated to remain at the same rate.

#### *7.1.1.b Drilling muds and cuttings*

No OBMs have been used at Platform Harvest since 2000 and none is forecast to be used through 2010. Drilling with WBM was conducted in 2000 through 2002 and may start again in 2007 and continue to 2010, at least. The average volumes of WBM and associated cuttings are summarized in Table 7-2. From 2000 to 2006, the total volume of all muds and cuttings generated was estimated at 31,327 bbls, with no drilling occurring in 2003 through 2006. All the WBM and cuttings were discharged overboard at the platform. No drilling wastes were injected.

In 2007, the operator could recommence drilling at a rate of 29,900 bbls of mud and cuttings a year. This volume is below the NPDES General Permit limit of 12,000 bbls of cuttings and 53,000 bbls of WBM per year. The same drilling rate is forecast to continue until 2010, with all material planned to be discharged overboard if drilling continues. The operator provided costs of $10,000 per year for the analytical testing and reporting that is required by the NPDES General Permit.

**Table 7-2**
**Platform Harvest WBM and Cuttings: Past (2000-2006) and Forecast (2007-2010) Discharge Volumes and Costs**

| Volume bbls | 2000-2006 Min | Max | Annual Average* | Total for Period | 2007-2020 Annual Volume | Total for Period |
|---|---|---|---|---|---|---|
| WBM generated | 0 | 21,399 | 10,442 | 31,327 | 23,500 | 94,000 |
| WBM Cuttings generated | 0 | 931 | 590 | 1,771 | 6,400 | 25,600 |
| WBM discharged | 0 | 100% | 100% | 100% | 100% | 100% |
| WBM Cuttings Discharged | 0 | 100% | 100% | 100% | 100% | 100% |
| % Injected | 0 | 0 | 0 | 0 | 0 | 0 |
| Discharge Costs | -- | 10 | 10 | 30 | 10 | 40 |

Note: * Average volumes for years when drilling occurred.
NPDES General Permit maximum annual allowable WMB discharge is 53,500 bbls per year.
NPDES General Permit maximum annual allowable WMB cuttings discharge is 12,000 bbls per year.

### 7.1.2 Alternatives to Discharge

#### *7.1.2.a Produced Water*

The majority of produced water from Platform Harvest is treated and discharged overboard. Less than 1 percent of the produced water is injected. From 2007 to 2010, the operator predicts that an average of 17.9 million bbls per year of produced water will be generated. This volume of water effectively limits the choice of alternatives to offshore injection into the producing formations as the only potentially feasible alternative to the overboard discharge of produced water.

Currently, the maximum forecast injection pumping rate is 4.8 bbls per hour (in 2010), which is equivalent to 42,000 bbls per year. This capacity is only 0.2 percent of the forecast produced water volume for 2010. Reservoir modeling and injectivity tests will be necessary to determine if the injection rate can be increased. If the testing indicates injection can be increased to 18 million bbls a year, then additional engineering studies would be required. Based on responses from other operators, additional equipment, perhaps structural enhancements to the platform work decks, and support facilities will be required to facilitate the injection of all the produced water generated. The following issues would be considered:

- A structural engineering study to verify that the existing decks are adequate to support the additional pumps, piping, and equipment that may be required.
- Engineering design for injection pumps, filters, equipment, piping, and fittings required for injection.
- Procurement of the injection pumps, filters, equipment, piping, and fittings.
- Additional power to run the treatment systems and injection pumps. The additional electrical power requirements would be

difficult if not impossible to maintain with limited produced gas turbine fuel. As oil (and thus natural gas) production is declining, it is projected that there will not be sufficient produced natural gas fuel to generate the needed power for ever increasing produced water volumes. The costs of installing a sub-sea power cable (estimated at $30 to $40 per foot) and purchasing onshore power and/or purchasing enough natural gas to provide the additional power needed would render the project uneconomic. In addition, permitting efforts for installation of a sub-sea power cable are estimated to take 3 to 4 years to complete and permitting costs are estimated at $2 million.

- Drilling of five new injection wells and conversion of existing wells.

**Technological factors:** Injection technology is in limited use on other platforms in the area. All equipment is readily available although lead time for procurement of some equipment may be significant (estimated at 24 to 36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for the injection rates necessary to match the produced water generation rates. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. High reservoir pressures are already maintained through contact with an active water aquifer which continually fills the formation as oil, water, and gas are produced. This has the affect of inhibiting additional water injection. Experience with the larger injection pump already installed has shown that the existing injection well (A-8) will not take much more produced water than it already is taking. In addition, water from different production reservoirs must be compatible with the water in the injection formation. The main potential problem associated with water incompatibility is scale and precipitate formation.

An evaluation of reservoir capacities, well bore hydraulics and injectivity tests will be required to determine if it is technically feasible to reliably inject the produced water that will be generated at Platform Harvest in the future. At the present time, it is uncertain if injection of produced water is technologically feasible.

**Environmental factors:** Injection of produced water has the benefit of removing a discharge from the ocean. However, the environmental benefit may be minor. As required under the general NPDES General Permit, the produced water already meets, after dilution, the more stringent of the Federal Water Quality Criteria or the California Ocean Plan objectives for 26 pollutants found to be present in produced water. The discharge occurs in the open ocean in

675 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor (MMS 2001a & 2001b). All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100-meter mixing zone.

If overboard discharge of produced water was prohibited, secondary impacts will increase, possibly significantly. Additional power will be required to run the additional water treatment equipment and injection pumps. Primary power at Platform Harvest is provided by onboard turbine generators powered by produced natural gas. This will result in additional air emissions on the platform. The emission increase from additional turbine power generation can be estimated at 70 lbs NOx per day per 1,000 hp needed for water injection. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. Capital, drilling, and completion costs for approximately five additional disposal wells would be in the range of $30 to $40 million (includes drill rig mob- and demobilization costs of $10 million). In addition, the estimated costs for acidizing and maintenance of each injection well is $250,000 per year. The annual average volume of produced water to be treated and injected is 17.9 million bbls per year, requiring multiple large capacity pumps to handle the volume as well as maintain adequate performance reliability, and the offshore location also contributes to the overall installation costs because of higher transportation costs and difficult working conditions offshore.

Engineering, procurement and installation of additional required tanks, pumps, piping, fittings, and controls would cost an estimated $5 million and additional deck fabrication would cost an estimated $30 million. Estimated operating costs could be as high as $3.3 million. The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection operations is likely to be negative.

Offshore injection and facility design is regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the produced water that is currently discharged overboard at Platform Harvest has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased emissions at a the platform due to injection operations, and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platform Harvest.

The significant capital and operating costs for injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as permitting from MMS and the SBCAPCD), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

Alternatives to Discharge

### 7.1.2.b *Drilling Muds & Cuttings*

At Platform Harvest, all WBM and associated cuttings have been discharged overboard over the past seven years (33,000 bbls from 2000 through 2006). For 2007 through 2010, the WBM and cuttings forecast for disposal is 29,900 bbls each year. No OBMs have been used since 2000 and none are planned to be used through 2010. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 53,500 and 12,000 bbls, respectively, for Platform Harvest.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection by fracturing technically acceptable formations or transporting to shore for disposal in a landfill.

#### 7.1.2.b.i *Injection of WBM and Cuttings*

The suitability of the hydrocarbon reservoirs for injection is not known. Only a small volume of produced water (less than 1 percent) has been injected in the past and a smaller percentage is predicted to be injected in the future, as the volume of produced water generated is increased.

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

At Platform Harvest, WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity than is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and well bores.

**Technological factors:** The technology is in use on some other platforms in the area, but only for injection rates that are much lower compared to the expected WBM and cuttings generation rates. Injection equipment is available. However, it is likely the needed equipment installation can not be accomplished without fabrication of additional deck space.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, porosity, and geological structure may limit the injection rates and total capacity. Injection of muds and cuttings or produced water has not been evaluated at Platform Harvest and the injectivity of large volumes of WBM and cuttings slurry may not be possible. Until such studies have been conducted, it is not feasible to consider 100 percent injection of WBM and cuttings.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001

WBM and cuttings are discharged from platforms in accordance with the General NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil or oil-based or synthetic-based fluids or toxic additives. In addition, drilling mud bioassays are required to be conducted for each mud system. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are being discharged to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the increased number of pumps. The platform power is supplied by produced natural gas powered turbines. One additional turbine would be needed to produce the necessary power with annual emissions for NOx at 20 tons per year. The additional emissions will be significant and render WBM and cuttings injection as environmentally infeasible.

**Economic factors:** Capital costs to add injection pumps for muds and cuttings would be similar to the costs estimated for injecting 100 percent of the produced water (approximately $2.5 million for major equipment and $30 million for deck/load work) assuming sufficient space could be built to house injection pumps for both produced water and muds). Capital, drilling, and completion costs for two additional disposal wells would be in the range of $12 million (excluding drill rig mob- and demobilization costs which were included in the produced water injection well drilling estimates). In addition, the estimated costs for acidizing and maintenance of each injection well is $425,000 per year. The significant capital and operating costs for injection make this option uneconomical relative to the current practice of overboard discharge, therefore this option is infeasible.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection is likely to be negative.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) renders the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Harvest has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for injection make this option uneconomical and infeasible relative to the current practice of overboard discharge

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as permitting from MMS and the SBCAPCD) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *7.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Relatively small volumes of drilling muds and cuttings are routinely transported from platforms to shore for treatment, recycling, or disposal. These volumes are generally only transported due to the following limited circumstances: (1) for OBM recycling (because it is economical to recycle OBM but not WBM), (2) because the cuttings fail the sheen test and therefore are not authorized for discharge and the particle size cannot be ground fine enough for injection, or (3) because injection capacity is full. The predicted WBM and cuttings volumes to be generated at Platform Harvest in 2007 through 2010 are 29,900 bbls a year. If this amount was to be transported to shore for disposal, instead of being discharged overboard, it would require 38 round trips by a supply boat each year. It is possible, depending on the drilling schedule, that one additional supply boat would be sufficient to transport to shore all the WBM and cuttings from the three Arguello-operated platforms.

**Technological factors:** There are no technological limits to the transportation of drilling muds to shore. As discussed above OBM and cuttings, and the WBM and cuttings that fail the sheen test due to formation hydrocarbons are usually transported in cuttings boxes, each holding 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. Transport from the unloading port to a suitable landfill facility in California can be accomplished using trucks. Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 7.1.2.b.i; Environmental factors).

In addition, the secondary impacts from air emissions would be significant. The primary regulated pollutants of concern in Santa Barbara County are NOx and reactive organic gases (ROG). Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment.

Emissions will be created from the supply vessels, from the trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks. An estimated 38 supply vessel trips would be required to transport 29,900 bbls of WBM and cuttings from Platform Harvest to Pt. Hueneme. The number of truck trips required to transport 29,900 bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be 650 truck trips, or approximately 2.5 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 23.5 tons of Nitrous oxides (NOx) and more than 5 tons of carbon monoxide (CO) per year. Additional emissions would occur during loading and unloading operations from the supply vessels and trucks. Total increased Reactive organic gases (ROG) and sulfur oxide (SOx) emissions would be approximately 2.5 and 3.1 tons per year, respectively. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 3rd quarter 2005 through 2nd quarter 2006) and the total permitted platform emissions is presented in Table 7-3.

**Table 7-3**
**Comparison of Estimated and Permitted Emissions at Platform Harvest**

| Emission Constituent | Total Annual Emissions (3rd Qtr 2005 to 2nd Qtr 2006; tons/year) | Estimated Increased Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 155.5 | 31 | 19.9% | 417.92 |
| CO | 81.9 | 9.9 | 12.1% | 201.86 |
| SOx | 24.08 | 3.1 | 12.9% | 54.53 |
| ROG | 49.97 | 2.5 | 5% | 84.4 |
| PM | 10.03 | 2.9 | 28.9% | 25.36 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. Permitting for the additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to transportation of the WBM and cuttings to shore for disposal as not feasible.

**Economic factors:** A typical supply boat charter is about $16,000 per day. A screening level cost for 38 roundtrips of 24 hours each is approximately $0.61 million. Typical landfill disposal charges are $10 to $20 per barrel with transportation costs of $2 to $4 per barrel. Landfill disposal costs for 29,900 bbls could range from $0.36 million to $0.72 million. The total costs for onshore disposal could range from $0.97 million to $1.33 million per year, which is substantially higher than the costs of overboard discharge. Transport to shore could increase operating costs by 81 percent to 117 percent over discharge costs, thereby making this disposal alternative economically infeasible to the operator.

**Social factors:** Public response to the increases in vessel traffic and truck traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, additional vessel traffic, increased truck traffic, and depletion of licensed disposal site capacity.

**Time factor:** Supply boats are available in small numbers in southern California. The operator has long-term contracts with vessel owners to provide one supply boat which is shared between the three Arguello-operated platforms. If necessary, vessels could be transferred from other locations in a few months. If supply vessels are not available the amount of time required to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that is currently discharged overboard at Platform Harvest has been assessed for feasibility as an alternative disposal method.

Environmental factors of significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within the County of Santa Barbara to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Transportation of WBM and cuttings to shore is technologically feasible.

Economic factors of an increase by 81 to 117 times the estimated costs of overboard discharge make this alternative economically infeasible to the operator.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as permitting from SBCAPCD) this alternative is considered infeasible.

The time required to procure additional supply boats and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan

## 7.2 PLATFORM HERMOSA

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Hermosa. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 7.2.1 Current practices

#### *7.2.1.a Produced Water*

The average annual volume of produced water generated at Platform Hermosa from 2000 through 2006 was 11.3 million bbls per year, with a minimum of 5.56 million bbls in 2000 and a maximum volume of 17.5 million bbls in 2003. The operator has forecast the produced water volume will increase to an annual average of 20.3 million bbls for 2007 through 2010 and reaching a maximum one-year volume of 23.3 million bbls in 2010 (Table 7-4). The maximum allowable discharge under the NPDES General Permit is 40.25 million bbls per year. Between 1 and 3.2 percent of the produced water is injected; the bulk of the volume is discharged overboard after treatment.

**Table 7-4**
**Platform Hermosa Produced Water Past (2000-2006) and Forecast (2007-2010) Discharges and Costs**

| | 2000-2006 | | | | 2007-2010 | | | |
|---|---|---|---|---|---|---|---|---|
| **Volume of Produced Water (bbls x 1,000)** | **Min** | **Max** | **Annual Average** | **Total for Period** | **Min** | **Max** | **Annual Average** | **Total for Period** |
| Generated | 5,568 | 17,507 | 11,315 | 79,206 | 17,507 | 23,302 | 20,312 | 81,250 |
| Discharged | 5,388 | 17,327 | 11,135 | 77,946 | 17,327 | 23,062 | 20,103 | 80,415 |
| Injected | 180 | 180 | 180 | 1,260 | 180 | 240 | 209 | 835 |
| % injected | 3.2% | 1.0% | 1.6% | 1.6% | 1.0% | 1.0% | 1.0% | 1.0% |
| Cost ($'000s) | | | | | | | | |
| Discharged | 1,616 | 5,198 | 3,340 | 23,381 | 5,198 | 6,919 | 6,031 | 24,124 |
| Injected | 54 | 54 | 54 | 378 | 54 | 72 | 63 | 251 |
| Total | 1,670 | 5,252 | 3,394 | 23,759 | 5,252 | 6,991 | 6,094 | 24,375 |
| Cost $/bbl | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

Note: NPDES General Permit maximum annual allowable produced water discharge is 40.25 million bbls per year.

The formation fluid from Platform Hermosa undergoes 3-phase separation (along with oil/water emulsion from Platform Hidalgo) on the platform which separates the gas, oil, and water. The stabilized merchantable oil is combined with merchantable oil from Platform Harvest then piped to the Gaviota Oil Heating facility where it is reheated and sold. The separated produced water is treated on Platform Hermosa by being passed through a series of oil-water coalescers and a gas floatation vessel to reduce the oil content further before the water is discharged overboard via a skim-pile vessel. The small percentage of produced water that cannot meet the NPDES General Permit discharge water quality requirements is injected.

Platform Hermosa produced water treatment and discharge costs are estimated by the operator at $0.30 per barrel (Table 7-4Table 7-4). This includes the costs for treatment system chemicals, required analytical testing, pumping operations, and maintenance costs. The cost to inject the small volume of produced water is also stated at $0.30 per barrel. Forecast costs for 2007 through 2010 are anticipated to remain at the same rate. However, because of the planned increase in the volume of produced water, the average annual discharge and injection operating costs will increase from $3.4 million in 2000 through 2006 to a forecast $6.1 million in 2007 through 2010.

#### *7.2.1.b Drilling muds and cuttings*

No drilling was conducted at Platform Hermosa from 2000 to 2006. Drilling is not currently scheduled for 2007 through 2010. If drilling occurs, WBM will be used.. No OBMs have been used at Platform Hermosa since 2000 and none is forecast to be used through 2010. The forecast average volumes of WBM and associated cuttings associated with the drilling plans are summarized in Table 7-5 and reflects volumes anticipated if drilling activities were to resume. All the WBM and cuttings are planned to be discharged overboard at the platform. No drilling wastes were injected.

In 2007, if the operator plans to recommence drilling, the expected rate of 29,900 bbls of mud and cuttings could be generated per year. This volume is well below the NPDES General Permit limit of 11,250 bbls of cuttings and 41,000 bbls of WBM per year. The same drilling rate is forecast to continue until 2010, with all material planned to be discharged overboard if drilling takes place. The operator provided costs of $10,000 per year for the analytical testing and reporting that is required by the NPDES General Permit.

**Table 7-5**
**Platform Hermosa WBM and Cuttings: Past (2000-2006) and Forecast (2007-2010) Discharge Volumes and Costs**

| | 2000-2006 | 2007-2010 | |
|---|---|---|---|
| **Volume (bbl x 1,000)** | **Total for Period** | **Annual Average** | **Total for Period** |
| WBM generated | 0 | 23.5 | 94 |
| WBM Cuttings generated | 0 | 6.4 | 25.6 |
| WBM discharged | 0 | 100% | 100% |
| WBM Cuttings Discharged | 0 | 100% | 100% |
| % Injected | 0 | 0 | 0 |
| Discharge Costs | NA | 10 | 40 |

Note: NPDES General Permit maximum annual allowable WMB discharge is 41,000 bbls per year.
NPDES General Permit maximum annual allowable WMB cuttings discharge is 11,250 bbls per year.

### 7.2.2 Alternatives to Discharge

#### *7.2.2.a Produced Water*

The majority of produced water from Platform Hermosa is treated and discharged overboard. Between 1 percent and 3.2 percent of the produced water has been injected in the past (Table 7-4). By 2010, the operator predicts that 23.3 million bbls per year of produced water will be generated, and 5 percent of the produced water could be injected in. This is equivalent to 1.2 million bbls per year injected, leaving 22.1 million bbls to be discharged overboard or transported to shore. The predicted volume of produced water effectively limits the choice of alternatives to offshore injection into the producing formations as the only potentially feasible alternative to the overboard discharge of produced water.

If the testing indicates injection can be increased to 23 million bbls a year, then additional engineering studies would be required prior to installing additional injection equipment. Based on responses from other operators, additional equipment, structural enhancements to the platform work decks, and support facilities will be required to facilitate the injection of all the produced water generated. The following issues would be considered:

- A deck extension to accommodate the additional treatment and pumping equipment if sufficient deck area is not available. A structural engineering study to verify that the existing decks are adequate to support the additional extension and equipment may be required.

- Engineering design for injection pumps, filters, equipment, piping, and fittings required for injection.

- Procurement of the injection pumps, filters, equipment, piping, and fittings.

- Additional power to run the treatment systems and injection pumps. The additional electrical power requirements would be difficult if not impossible to maintain with limited produced gas turbine fuel. As oil (and thus natural gas) production is declining, it is projected that there will not be sufficient produced natural gas fuel to generate the needed power for ever increasing produced water volumes. The costs of installing a sub-sea power cable (estimated at $30 to $40 per foot) and purchasing onshore power and/or purchasing enough natural gas to provide the additional power needed would render the project uneconomic. In addition, permitting efforts for installation of a sub-sea power cable are estimated to take 3 to 4 years to complete and permitting costs are estimated at $2 million.

- Drilling of new injection wells and conversion of existing wells.

**Technological factors:** Injection technology is in limited use on other platforms in the area. All equipment is readily available although lead time for procurement of some equipment may be significant (estimated at 24 to 36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for the injection rates necessary to match the produced water generation rates. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. High reservoir pressures are already maintained through contact with an active water aquifer which continually fills the formation as oil, water, and gas are produced. This has the affect of inhibiting additional water injection. In addition, water from different production reservoirs must be compatible with the water in the injection formation. The main potential problem associated with water incompatibility is scale and precipitate formation.

An evaluation of reservoir capacity, well bore hydraulics, and injectivity tests will be required to determine if it is technically feasible to reliably inject the produced water that will be generated at

Platform Hermosa in the future. At the present time, it is uncertain if injection of produced water is technologically feasible.

**Environmental factors:** Injection of produced water has the benefit of removing a discharge from the ocean. However, the environmental benefit may be minor. As required under the general NPDES General Permit, the produced water already meets, after dilution, the more stringent of the Federal Water Quality Criteria or the California Ocean Plan objectives for 26 pollutants found to be present in produced water. The discharge occurs in the open ocean in 600 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor (MMS 2001a & 2001b). All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100-meter mixing zone.

If overboard discharge of produced water was prohibited, secondary impacts will increase. Additional power will be required to run the additional water treatment equipment and injection pumps. Primary power at Platform Hermosa is provided by onboard turbine generators powered by produced natural gas. This will result in additional air emissions on the platform. The emission increase from additional turbine power generation can be estimated at 70 lbs NOx per day per 1,000 hp needed for water injection. In addition, it is possible that additional generation capacity would not be available and new generation equipment would have to be permitted and the emission increases offset. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. Capital, drilling, and completion costs for approximately five additional disposal wells would be in the range of $30 to $40 million (includes drill rig mob- and demobilization costs of $10 million). In addition, the estimated costs for acidizing and maintenance of each disposal well is $250,000 per year. The volume of produced water to be treated and injected is 23 million bbls per year, requiring multiple large capacity pumps to handle the volume as well as maintain adequate performance reliability, and the offshore location also contributes to the overall installation costs because of higher transportation costs and difficult working conditions offshore.

Engineering, procurement and installation of additional required tanks, pumps, piping, fittings, and controls would cost an estimated $5 million and additional deck fabrication would cost another estimated $30 million. Estimated operating costs could be as high as

$3.3 million per year. The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection operations is likely to be negative.

Offshore injection and facility design is regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the produced water that is currently discharged overboard at Platform Hermosa has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, in increased emissions at a the platform due to injection operations, and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platform Hermosa.

The significant capital and operating costs for produced water injection makes this option uneconomical and infeasible relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as permitting from MMS and the SBCAPCD), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *7.2.2.b Drilling Muds & Cuttings*

No drilling was conducted at Platform Hermosa from 2000 through 2006. Drilling is not currently scheduled in 2007 through 2010. If drilling does take place in 2007 through 2010, the WBM and cuttings forecast to require disposal is 29,900 bbls each year. No OBMs are planned to be used through 2010. If drilling was to commence, the 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 41,000 and 11,250 bbls, respectively, for Platform Hermosa.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection into the production formations and transporting to shore for disposal in a landfill.

##### *7.2.2.b.i Injection of WBM and Cuttings*

The suitability of the hydrocarbon reservoirs for injection is not known. Only a small volume of produced water (1 percent to 3 percent) has been injected in the past.

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and well bores.

**Technological factors:** The technology is in use on some other platforms in the area, but only for injection rates that are much lower compared to the expected WBM and cuttings generation rates. Injection equipment is available. However, it is likely the needed equipment installation can not be accomplished without fabrication of additional deck space.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, porosity, and geological structure may limit the injection rates and total capacity. Injection of muds and cuttings or produced water has not been evaluated at Platform Hermosa and the injectivity of large volumes of WBM and cuttings slurry may not be possible. Until such studies have been conducted, it is not feasible to consider injection of WBM and cuttings.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001.

WBM and cuttings are discharged from platforms in accordance with the General NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil or oil-based or synthetic-based fluids or toxic additives. In addition, drilling mud bioassays are required to be conducted for each mud system. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are being discharge to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the increased number of pumps. The platform power is supplied by produced natural gas powered turbines. The emission increase from additional turbine power generation can be estimated at 70 lbs NOx per day per 1,000 hp needed for WBM and cuttings injection. In addition, it is possible that additional generation capacity would not be available and new generation equipment would have to be permitted and the emission increases offset. It is likely that the additional emissions will be significant and render WBM and cuttings injection as environmentally infeasible.

**Economic factors:** Capital costs to add injection pumps for muds and cuttings would be similar to and in addition to the costs estimated for injecting 100 percent of the produced water (approximately $2.5 million for major equipment and piping, and $30 million for deck/load work, assuming sufficient space could be built to house injection pumps for both produced water and muds). Two injection wells are estimated to be needed at a cost of $6 million per well (not including mobilization and demobilization costs (which are included in the produced water injection well drilling cost estimate). In addition, the estimated costs for acidizing and maintenance of each disposal well is $425,000 per year. The significant capital and operating costs for injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection is likely to be negative.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as permitting from MMS and the SBCAPCD) renders the social factor to WBM and cuttings injection as infeasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Hermosa has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs make this option uneconomical and therefore infeasible relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

*7.2.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Relatively small volumes of drilling muds and cuttings are routinely transported from platforms to shore for treatment, recycling, or disposal. These volumes are generally only transported due to the following limited circumstances: (1) for OBM recycling (because it is economical to recycle OBM but not WBM), (2) because the cuttings fail the sheen test and therefore are not authorized for discharge and the particle size cannot be ground fine enough for injection, or (3) because injection capacity is full. The predicted WBM and cuttings volumes generated at Platform Hermosa in 2007 through 2010 could be 29,900 bbls a year. If this amount was to be transported to shore for disposal, instead of being discharged overboard, it would require 38 round trips by a supply boat each year. It is possible, depending on the drilling schedule, that one additional supply boat could be sufficient to transport to shore all the WBM and cuttings from the three Arguello-operated platforms (Harvest, Hermosa, and Hidalgo).

**Technological factors:** There are no technological limits to the transportation of drilling muds to shore. As discussed above, OBM and cuttings and the WBM and cuttings that fail the sheen test due to formation hydrocarbons are usually transported in cuttings boxes, each holding 23 bbls of mud. One supply vessel can carry 35 boxes, equivalent to 805 bbls per trip. Transport from the unloading port to a suitable landfill facility in California can be accomplished using trucks. Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 7.2.2.b.i; Environmental factors).

In addition, the secondary impacts from air emissions would be significant. The primary regulated pollutants of concern in Santa Barbara County are NOx and ROG. Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment.

Emissions will be created from the supply vessels, from the trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks. An estimated 38 supply vessel trips would be required to transport 29,900 bbls of WBM and cuttings from Platform Hermosa to Pt. Hueneme. The number of truck trips required to transport 29,900 bbls of mud and cuttings from Pt.

Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be 650 truck trips, or approximately 2.5 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 23 tons of Nitrous oxides (NOx) and more than 7 tons of carbon monoxide (CO) per year. Additional emissions would occur during loading and unloading operations from the supply vessels and trucks. Total increased Reactive organic gases (ROG) and sulfur oxides (SOx) emissions would be approximately 2.8 and 3 tons per year, respectively. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 3rd quarter 2005 through 2nd quarter 2006) and the total permitted platform emissions is presented in Table 7-6.

**Table 7-6**
**Comparison of Estimated and Permitted Emissions at Platform Hermosa**

| Emission Constituent | Total Annual Emissions (3rd Qtr 2005 to 2nd Qtr 2006; tons/year) | Estimated Increased Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 60.82 | 30 | 49.3% | 192.62 |
| CO | 18.73 | 9.8 | 52.3% | 113.16 |
| SOx | 11.93 | 3.0 | 25.1% | 48.79 |
| ROG | 39.02 | 2.5 | 6.4% | 75.67 |
| PM | 2.6 | 2.8 | 107.7% | 17.21 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. Permitting for the additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to transportation of the WBM and cuttings to shore for disposal as not feasible.

**Economic factors:** A typical supply boat charter is about $16,000 per day. A screening level cost for 38 roundtrips of 24 hours each is approximately $0.61 million. Typical landfill disposal charges are $10 to $20 per barrel with transportation costs of $2 to $4 per barrel. Landfill disposal costs for 29,900 bbls could range from $0.36 million to $0.72 million. The total costs for onshore disposal could range from $0.97 million to $1.33 million per year, which is substantially higher than the costs of overboard discharge. Transport to shore could increase operating costs by 81 percent to 117 percent over discharge costs, thereby making this disposal alternative economically infeasible to the operator.

**Social factors:** Public response to the increases in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, additional vessel traffic, increased truck traffic, and depletion of licensed disposal site capacity.

**Time factor:** Supply boats are available in small numbers in southern California. The operator has long-term contracts with vessel owners to provide one supply boat which is shared between the three Arguello-operated platforms (Harvest, Hermosa, and Hidalgo). If necessary, vessels could be transferred from other locations in a few months. If supply vessels are not available, the amount of time to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that is currently discharged overboard at Platform Hermosa has been assessed for feasibility as an alternative disposal method.

Environmental factors of significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within the Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Transportation of WBM and cuttings to shore is technologically feasible.

Economic factors of an increase by 81 to 117 times the estimated costs of overboard discharge make this alternative economically infeasible to the operator.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as permitting from SBCAPCD) this alternative is considered infeasible.

The time required to procure additional supply boats and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

## 7.3 PLATFORM HIDALGO

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Hidalgo. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 7.3.1 Current practices

#### *7.3.1.a Produced Water*

The average annual volume of produced water generated at Platform Hidalgo was 2.4 million bbls per year from 2000 through 2006. The operator has forecast the produced water volume to have an average annual volume of 4.5 million bbls per year for 2007 through 2010 and reaching a maximum one year volume of 5.1 million bbls in 2010 (Table 7-7). The maximum allowable discharge under the

NPDES General Permit is 18.25 million bbls per year. Approximately 15 percent of the produced water is injected; the bulk of the volume is discharged overboard after treatment.

**Table 7-7**
**Platform Hidalgo Produced Water Past (2000-2006) and Forecast (2007-2010) Discharges and Costs**

| Volume of Produced Water (bbls x 1,000) | 2000-2006 | | | | 2007-2010 | | | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Annual Average | Total for Period | Min | Max | Annual Average | Total for Period |
| Generated | 1,750 | 3,865 | 2,367 | 16,571 | 3,865 | 5,114 | 4,484 | 17,937 |
| Discharged | 1,357 | 17,327 | 1,999 | 13,990 | 3,447 | 4,588 | 3,999 | 15,998 |
| Injected | 72 | 534 | 368 | 2,581 | 534 | 711 | 619 | 1,939 |
| % injected | -- | -- | 15.5% | 15.6% | -- | -- | 13.8% | 13.8% |
| Cost ($'000s) | | | | | | | | |
| Discharged | 407 | 1,034 | 600 | 4,197 | 1,034 | 1,376 | 1,200 | 4,799 |
| Injected | 22 | 160 | 111 | 774 | 160 | 213 | 186 | 743 |
| Total | -- | -- | 711 | 4,971 | 1,194 | 1,589 | 1,386 | 5,542 |
| Cost $/bbl | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

Note: -- Minimum and maximum values did not occur in the same year.
NPDES General Permit maximum annual allowable produced water discharge is 18.25 million bbls per year.

Total fluid production (an oil/produced water emulsion) from Platform Hidalgo undergoes initial processing to reduce water and sediment content prior to being shipped via sub-sea pipeline to Platform Hermosa where it commingles with the Platform Hermosa production and is stabilized for further processing. Merchantable oil from Platforms Harvest, Hermosa, and Hidalgo are shipped from Platform Hermosa via sub-sea pipeline to the Gaviota Oil Heating Facility where it is reheated and sold for re-heating and sale. All produced water is treated on-platform through a series of oil-water coalescers and a flotation cell to remove the carry-over oil prior to discharge or injection.

The average annual cost between 2000 through 2006 for treatment and discharge of produced water generated at Platform Hidalgo was estimated at $599,500 per year for discharge and $110,600 for injection. The average annual produced water production rate during the same period was approximately 2.4 million bbls per year (equivalent to approximately 272,000 gallons per day), of which 2 million bbls per year was discharged overboard and 369,000 bbls per year was injected. This is equivalent to an average cost of approximately $0.30 per barrel for discharge and $0.30 per barrel for injection.

*7.3.1.b Drilling muds and cuttings*

The average volumes of WBM, OBMs, and associated cuttings are summarized in Table 7-8. OBMs were not used at Platform Hidalgo from 2000 through 2003, and WBM were not used in 2002. From

2000 through 2006, the total volume of all muds and cuttings generated at Platform Hidalgo was estimated at 213,623 bbls (140,600 bbls of OBM and cuttings and 73,023 bbls of WMB and cuttings). One-hundred percent of the WBM and cuttings were discharged overboard at the platform. For 2004 through 2006 a total of 6,634 bbls of OBM and cuttings were transported to shore for recycling. The remaining 133,937 bbls of the OBM and cuttings were injected.

Between 2007 and 2010, the operator is planning to increase the WBM usage to 23,500 bbls per year. During that same period, the operator will discontinue the use of OBMs. From 2007 through 2010, the operator expects to discharge to the ocean all WBM and cuttings.

**Table 7-8**
**Platform Hidalgo WBM and Cuttings: Past (2000-2006) and Forecast (2007-2010) Discharge Volumes and Costs**

| Volume (bbl x 1,000) | 2000-2006 | | | | 2007-2010 | |
|---|---|---|---|---|---|---|
| | Min | Max | Annual Average* | Total for Period | Annual Average | Total for Period |
| WBM generated | 0 | 23.5 | 10.2 | 61 | 23.5 | 94 |
| WBM Cuttings generated | 0 | 6.3 | 2 | 11.9 | 6.4 | 25.6 |
| WBM discharged | 0 | 100% | 100% | 100% | 100% | 100% |
| WBM Cuttings Discharged | 0 | 100% | 100% | 100% | 100% | 100% |
| % Injected | 0 | 0 | 0 | 0 | 0 | 0 |
| Discharge Costs | NA | NA | NA | NA | 10 | 40 |

Note: * Average volumes for years when drilling occurred.
NPDES General Permit maximum annual allowable WMB discharge is 23,000 bbls per year starting 12/04.
NPDES General Permit maximum annual allowable WMB cuttings discharge is 6,000 bbls per year.

### 7.3.2 Alternatives to Discharge

#### *7.3.2.a Produced Water*

All produced water is treated on-platform prior to discharge or injection. By 2010, the operator predicts that 5.1 million bbls of produced water will be generated and that 13.8 percent of the produced water could be injected in future years. The predicted volume of produced water effectively limits the choice of alternatives to offshore injection into the producing formations as the only potentially feasible alternative to the overboard discharge of produced water.

Currently the maximum forecast injection pumping rate is 82.0 bbls per hour (2010 forecast rate), which is equivalent to approximately 720,000 bbls per year. Reservoir modeling and injectivity test will be necessary to determine if the injection rate can be increased. If the testing indicates injection can be increased to 5.1 million bbls a year, then additional engineering studies would be required prior to installing additional injection equipment. Based on responses from other operators, additional equipment, structural enhancements to the platform work decks, and support facilities will be required to facilitate the injection of all the produced water generated. The following issues would be considered:

- A structural engineering study to verify that the existing decks are adequate to support the additional pumps, piping, and equipment that may be required.
- Engineering design for injection pumps, filters, equipment, piping, and fittings required for injection.
- Procurement of the injection pumps, filters, equipment, piping, and fittings.
- Additional power to run the treatment systems and injection pumps. The additional electrical power requirements would be difficult if not impossible to maintain with limited produced gas turbine fuel. As oil (and thus natural gas) production is declining, it is projected that there will not be sufficient produced natural gas fuel to generate the needed power for ever increasing produced water volumes. The costs of installing a sub-sea power cable (estimated at $30 to $40 per foot) and purchasing onshore power and/or purchasing enough natural gas to provide the additional needed would render the project uneconomic. In addition, permitting efforts for installation of a sub-sea power cable are estimated to take 3 to 4 years to complete and permitting costs are estimated at $2 million.
- Drilling of five new injection wells and conversion of existing wells.

**Technological factors:** Injection technology is in limited use on other platforms in the area. All equipment is readily available although lead time for procurement of some equipment may be significant (estimated at 24 to 36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for the injection rates necessary to match the produced water generation rates. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. High reservoir pressures are already maintained through contact with an active water aquifer which continually fills the formation as oil, water, and gas are produced. This has the affect of inhibiting additional water injection. In addition, water from different production reservoirs must be compatible with the water in the injection formation. The main potential problem associated with water incompatibility is scale and precipitate formation.

An evaluation of reservoir capacity, well bore hydraulics, and injectivity tests will be required to determine if it is technically feasible to reliably inject the produced water that will be generated at Platform Hidalgo in the future. At the present time, it is uncertain if injection of produced water is technologically feasible.

**Environmental factors:** Injection of produced water has the benefit of removing a discharge from the ocean. However, the environmental benefit may be minor. As required under the general NPDES General Permit, the produced water already meets, after dilution, the more stringent of the Federal Water Quality Criteria or the California Ocean Plan objectives for 26 pollutants found to be present in produced water. The discharge occurs in the open ocean in 430 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor (MMS 2001a & 2001b). All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100-meter mixing zone.

If overboard discharge of produced water was prohibited, secondary impacts will increase. Additional power will be required to run the additional water treatment equipment and injection pumps. Primary power at Platform Hidalgo is provided by onboard turbine generators powered by produced natural gas. This will result in additional air emissions on the platform. The emission increase from additional turbine power generation can be estimated at 70 lbs NOx per day per 1000 hp needed for water injection. In addition, it is possible that additional generation capacity would not be available and new generation equipment would have to be permitted and the emission increases offset. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. Capital, drilling, and completion costs for approximately two additional disposal wells would be in the range of $15 to $20 million (includes drill rig mob- and demobilization costs of $10 million). In addition, the estimated costs for acidizing and maintenance of each disposal well is $250,000 per year. The volume of produced water to be treated and injected is high, up to 5.14 million bbls in 2010, requiring multiple large capacity pumps to handle the volume as well as maintain adequate performance reliability, and the offshore location also contributes to the overall installation costs because of higher transportation costs and difficult working conditions offshore.

Engineering, procurement and installation of additional required tanks, pumps, piping, fittings, and controls would cost an estimated $2.5 million and additional deck fabrication would cost another estimated $30 million. Estimated operating costs could be as high as $3.3 million. The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection operations is likely to be negative.

Offshore injection and facility design is regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the produced water that is currently discharged overboard at Platform Hidalgo has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased emissions at a the platform due to injection operations, and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platform Hidalgo.

The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as permitting from MMS and the SBCAPCD), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *7.3.2.b Drilling Muds & Cuttings*

At Platform Hidalgo, OBMs will not be used from 2007 through 2010. All WBM and associated cuttings were discharged overboard from 2000 through 2006, and will continue to be discharged overboard from 2007 through 2010 if drilling occurs. This alternatives feasibility study focuses on the portion of WBM that are discharged overboard. From 2007 to 2010, the operator estimates the average annual discharge of WBM and cuttings to be 29,000 bbls per year if drilling is taking place.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings: injection into the production formations and transportation to shore for disposal in a landfill.

##### *7.3.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and well bores.

**Technological factors:** The technology is currently in use on Platform Hidalgo. All equipment is available.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, porosity, and geological structure may limit the injection rates and total capacity. Injectivity testing will be required to determine if it is technically feasible to reliably inject 100 percent of WBM and cuttings that will be generated at Platform Hidalgo in the future. Until such studies have been conducted, it is not feasible to consider injection of WBM and cuttings.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the General NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil or oil-based or synthetic-based fluids or toxic additives. In addition, drilling mud bioassays are required to be conducted for each mud system. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are being discharged to the ocean.

Secondary environmental impacts may result from the additional power requirements to run the increased number of pumps. The platform power is supplied by produced natural gas powered turbines. The emission increase from additional turbine power generation can be estimated at 70 lbs NOx per day per 1,000 hp needed for WBM and cuttings injection. In addition, it is possible that additional generation capacity would not be available and new generation equipment would have to be permitted and the emission increases offset. It is likely that the additional emissions will be significant and render WBM and cuttings injection as environmentally infeasible.

**Economic factors:** Structural modifications and additional pumps and equipment to inject WBM and cuttings may be required. Two injection wells are estimated to be required at a cost of $6 million per well (not including mobilization and demobilization costs). In addition, the estimated costs for acidizing and maintenance of each disposal well is $425,000 per year. Insufficient information is available to determine screening level costs. However, based on the estimates from another operator, capital costs could be in the order of $3 million with estimated operating costs of $700,000 per year. The significant capital and operating costs for injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection plans is unknown.

The uncertainty in the regulatory approval considerations (MMS approval) renders the social factor to WBM and cuttings injection as uncertain.

**Time Factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings to be discharged overboard at Platform Hidalgo has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for injection make this option uneconomical and infeasible relative to the current practice of overboard discharge.

Social factors are mixed. However, the uncertainty in the regulatory approval considerations (MMS approval) renders the social factor to WBM and cuttings injection as uncertain.

The time required to accomplish the operational changes from overboard discharge to injection is feasible.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

##### *7.3.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. However, the volumes are relatively small. These volumes are generally only transported due to the following limited circumstances: (1) for OBM recycling (because it is economical to recycle OBM but not WBM), (2) because the cuttings fail the sheen test and therefore are not authorized for discharge and the particle size cannot be ground fine enough for injection, or (3) because injection capacity is full. For example, at Platform Hidalgo, only 4.7 percent of the total volume of OBM and cuttings generated between 2000 and 2006 was returned to shore for recycling. For 2007 through 2010, the projected annual average volume of WBM and cuttings requiring disposal is 29,000 bbls annually. If 29,000 bbls of WBM and cuttings were transported to shore for disposal instead of being discharged overboard, it would be an increase of approximately 4.5 times the total OBM volume for 2000 through 2006.

**Technological factors:** There are no technological limits to the transportation of drilling muds to shore. As discussed above, OBM and cuttings and the WBM and cuttings that fail the sheen test due to formation hydrocarbons can be transported in cuttings boxes, each holding 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. Transport from the unloading port to a suitable landfill facility in California can be accomplished using trucks. Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 7.3.2.b.i; Environmental factors).

In addition, the secondary impacts from air emissions may be significant. The primary regulated pollutants of concern in Santa Barbara County are NOx and ROG. Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment.

Emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks. An estimated 38 supply vessel trips would be required to transport 29,000 bbls of WBM and cuttings from Platform Hermosa to Pt. Hueneme. The number of truck trips required to transport 29,000 bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be 650 truck trips, or approximately 2.4 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 24.4 tons of NOx and more than 7.3 tons of CO per year. Additional emissions would occur during loading and unloading operations from the supply vessels and trucks. Total increased ROG and SOx emissions would be approximately 2.5 and 3.2 tons per year, respectively. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 3rd quarter 2005 through 2nd quarter 2006) and the total permitted platform emissions is presented in Table 7-9.

**Table 7-9**
**Comparison of Estimated and Permitted Emissions at Platform Hidalgo**

| Emission Constituent | Total Annual Emissions (3rd Qtr 2005 to 2nd Qtr 2006; tons/year) | Estimated Increased Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 69.06 | 32 | 46.3% | 194.5 |
| CO | 27.28 | 10.1 | 37% | 92.46 |
| SOx | 14.91 | 3.2 | 21.5% | 40.07 |
| ROG | 31.35 | 2.5 | 8% | 60.59 |
| PM | 4.25 | 3.0 | 7.1% | 17.1 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. Permitting for the additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to transportation of the WBM and cuttings to shore for disposal as not feasible.

**Economic factors:** A typical supply boat charter is about $16,000 per day. A screening level cost for 38 roundtrips of 24 hours each is approximately $456,000. Typical landfill disposal charges are $10 to $20 per barrel with transportation costs of $2 to $4 per barrel. Landfill disposal costs for 29,900 bbls could range from $359,000 to $718,000. The total costs for onshore disposal could range from $815,000 to $1,174,000 per year, which is substantially higher than the costs of overboard discharge. Transport to shore could increase operating costs by 81 percent to 117 percent making this disposal alternative economically infeasible to the operator.

**Social factors:** Public response to the increases in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, additional vessel traffic, increased truck traffic, and depletion of licensed disposal site capacity.

**Time factor:** Supply boats are available in small numbers in southern California. The operator has long-term contracts with vessel owners to provide one supply boat which is shared between the three Arguello-operated platforms (Harvest, Hermosa, and Hidalgo). If necessary, vessels could be transferred from other locations in a few months. If supply vessels are not available, the amount of time to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that is currently discharged overboard at Platform Hidalgo has been assessed for feasibility as an alternative disposal method.

Environmental factors of significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within the Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Transportation of WBM and cuttings to shore is technologically feasible.

Economic factors of an increase by 81 to 117 times the estimated costs of overboard discharge make this alternative economically infeasible to the operator.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as SBCAPCD permitting) make this alternative infeasible.

The time required to procure additional supply boats and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

# 8.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS - EXXONMOBIL

## 8.1 PLATFORM HARMONY

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Harmony. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM and associated cuttings are described.

### 8.1.1 Current practices

#### *8.1.1.a Produced Water*

The average annual volume of produced water generated at Platform Harmony for 2000-2005 was 5.4 million bbls. A similar rate is forecast for 2006 through 2010.

Total fluid production (an oil/produced water emulsion) from Platforms Harmony, Heritage, and Hondo is routed onshore via pipeline to ExxonMobil's Las Flores Canyon (LFC) Facility. At LFC free oil is removed from the emulsion. Produced water from the inlet separation is routed to pressurized plate separators and media filters for removal of dispersed oil and solids. Hydrochloric acid is then injected into the water to facilitate removal of sulfur compounds in a Vacuum Flash Tower. The water is then routed through closed tanks for treatment by anaerobic bacteria to remove soluble organic compounds. The water is then routed to basins for aeration and final polishing by aerobic bacteria. After residence time in clarifiers to facilitate the capture of inert and biological solids the treated produced water is pumped offshore via pipeline to Harmony for overboard discharge.

The costs for the treatment and discharge of the produced water from Platforms Harmony, Heritage, and Hondo have been estimated to be about $2 million per year through 2006. The average annual produced water production rates for Platforms Harmony, Heritage, and Hondo are estimated at 13.7 million bbls per year (equivalent to approximately 1.6 million gallons per day). This is equivalent to a per barrel average cost of approximately $0.15 over the past five years with similar costs forecast through 2010.

#### *8.1.1.b Drilling muds and cuttings*

WBM and cuttings were generated in 2002 and 2003. OBM and cuttings were generated only in 2003. Average, annual, and projected volumes of WBM and cuttings and OBM and cuttings are summarized in Table 8-1. From 2002 through 2003, the total volume of all muds and cuttings generated was estimated at 200,084 bbls, with WBM making up approximately 77 percent of the total. Approximately 80 percent of the WBM and cuttings were discharged overboard at the platform and the remaining 20 percent was injected. For OBM, 83 percent was injected along with all the associated cuttings and approximately 17 percent of the OBM was separated and returned to the vendor for reuse.

Although drilling plans are uncertain in 2007, the operator may begin a drilling program at Platform Harmony, with an estimated maximum WBM usage of 187,500 bbls for the year. An increase in the use of OBM is also anticipated. From 2008 through 2010, plans are also uncertain but approximately 1.5 times the 2000 - 2006 annual volumes can be used for forecasting future volumes. No changes are expected in the proportions of muds and cuttings that are discharged overboard, injected, and recycled when drilling.

WBM and cuttings were generated in 2002 and 2003. The estimated annual costs for injection of WBM and cuttings ranged from $13.42 to $26.00 per barrel. OBM and cuttings were generated in 2003. The estimated annual cost for injection of OBM and cuttings was $71.05 per barrel. Future costs are anticipated to be higher but not significantly higher than the 2003 costs. Costs for overboard discharge of WBM and cuttings are not tracked by the operator. However, other operators with similar operations estimate a $0.30 per bbl cost for overboard discharge.

**Table 8-1**
**Drilling Muds & Cuttings Volumes Generated at Platform Harmony**

| Annual average (bbl/year) | 2002 | 2003 | Average* | 2007 | 2008-2010 |
|---|---|---|---|---|---|
| Water Based Mud | 53,355 | 102,525 | 77,940 | 187,500 | 112,500 |
| WBM Cuttings | 7,114 | 13,670 | 10,393 | 25,000 | 15,000 |
| Oil Based Mud | NA | 17,565 | 17,565 | 24,000 | 24,000 |
| OBM Cuttings | NA | 5,855 | 5,855 | 8,000 | 8,000 |
| **Total** | **60,469** | **139,615** | **111,753** | **244,500** | **159,500** |

*Average volumes per year when drilling occurred

### 8.1.2 Alternatives to Discharge

#### *8.1.2.a Produced Water*

Although produced water from Platform Harmony, mixed with produced water from Platform Heritage and Platform Hondo, is transported to shore for treatment via pipeline, there are no available onshore facilities with the capacity to accept the volume of produced water generated (633,000 gallons per day for Harmony alone) for disposal via injection.

In 2007, the operator predicts 5.7 million bbls of produced water generated at Platform Harmony will be discharged to the ocean. The 2007 through 2010 projected annual discharge volumes for produced water is below the allowable NPDES permit limit of 33,762,000 bbls (less any produced water volumes discharged from Platforms Heritage and Hondo) that can be discharged at Platform Harmony.

Because of the large volumes of produced water generated at Platform Harmony, only one method has been identified as being a potentially feasible alternative to the overboard discharge of produced water at Platform Harmony and that is injection back into the hydrocarbon formation or into suitable surrounding strata that can accept the produced water generated. To change operations at Platform Harmony to inject all produced water generated, the following equipment and support facilities would be required:

- Treatment equipment to change from a 2-phase separation system to a 3-phase separation system. Currently, after the gas phase is separated from the reservoir fluids, the remaining oil/water emulsion is sent to shore for further treatment. For injection on the platform the produced water would be separated from the oil/water emulsion before injection.
- One deck extension to accommodate the additional treatment and pumping equipment. In addition, a structural engineering study would be required to determine if it is feasible for the existing platform structure to support the additional extension and equipment.
- Injection pumps and piping and fittings.
- Additional power to run the treatment systems and injection pumps.
- Engineering design for the additional deck extension and equipment to be installed.
- Drilling of a new injector well and conversion of several existing wells to injection wells.

**Technological factors:** Injection technology is in use to a limited extent on Platform Harmony and other platforms in the area. All equipment is readily available although lead times for procurement of some equipment may be significant (estimated at 24 to 36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for injection rates necessary to match the produced water generation rates. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. In addition, water from different production reservoirs must be compatible. The main potential problem associated with water incompatibility is scale and precipitate formation. Injection of produced water has been evaluated at Platform Harmony. The evaluation involved the use of reservoir simulation studies in which injection wells have been modeled with wellbore hydraulics using wellhead pressure constraints. Limited field injectivity tests using one well have also been carried out.

Additional field testing and confirmation of the reservoir modeling results would be necessary before the technical feasibility of injection of 100 percent of the produced water could be determined. At the present time, it is uncertain if injection of 100 percent of the produced water is technologically feasible.

**Environmental factors:** The produced water discharge from Platform Harmony currently complies with water quality limitations contained in NPDES General Permit. The discharge occurs in the open ocean in approximately 1,200 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor. All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100 m mixing zone (MMS 2001a & 2001b).

If overboard discharge of produced water was prohibited, additional power would be required to run the necessary water treatment equipment and injection pumps. Since the power would come from the onshore electricity grid, the associated secondary environmental impacts (additional air emissions) would be at the point of power generation. In addition, the risk of leaks and spills of oil and untreated produced water would increase because of the additional piping, valves, and treatment vessels required for the treatment and separation systems and the injection pumping systems. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. The volume of produced water to be treated and injected is high, 5.7 million bbls per year, requiring large capacity treatment systems and pumps to handle the volume as well as to maintain adequate pumping equipment redundancy and performance reliability. The available deck space on the platform is inadequate, requiring additional construction.

The operator prepared a screening level cost estimate for the purchase and installation of the major equipment required for injection. The cost estimate is broken down into major components, design and construction, and drilling costs. The cost for design, procurement, and installation of the deck extension and the treatment and injection system is estimated at approximately $15.8 million with an additional cost of $20.5 million to prepare four injection wells for a total capital expenditure of approximately $36.3 million (Table 8-2).

**Table 8-2**
**Capital Costs for Injection Equipment & Installation at Platform Harmony**

| Platform Harmony Equipment & Installation Items | Cost ($'000s) |
|---|---|
| 3-Phase Separation System Installation | $9,743 |
| 1 Deck Extension | $750 |
| System Piping and Fittings | $360 |
| Injection Pumps (900 hp) | $1,080 |
| Construction of Motor Control Center Buildings | $1,000 |
| Engineering Design | $591 |
| Contingency Costs (15%) | $2,266 |
| **Total Platform Facilities Installation Cost** | **$15,790** |
| | |
| Number of Existing Wells to be Converted to Injection | 3 |
| Number of New Wells to Drill | 1 |
| Drilling Costs | $20,500 |
| **Total Costs for Drilling & Facilities** | **$36,290** |

Note: - The costs presented do not include lost revenue due to production downtime for retrofitting separators and completing tie-ins to existing systems.

Screening level operating costs for the treatment and injection system were calculated by the operator and are presented in Table 8-3. The major components of the operating costs are:

- Electrical power (supplied via submarine cable from the onshore electricity grid), operations, and maintenance for the 900 hp centrifugal pumps.
- Costs for consumable chemicals, required for the 3-phase treatment system to separate the oil and emulsion from the produced water before injection.

The estimated annual average operating costs are $3.3 million.

**Table 8-3**
**Operating Costs for Treatment and Injection of Produced Water at Platform Harmony**

| Platform Harmony Injection Operations Costs | Cost ($'000s /year) |
|---|---|
| Electrical - Pumps only | $588 |
| Electrical - Auxiliary and Control Systems | $118 |
| Chemical Costs for 3-phase separation treatment | $2,628 |
| **Total Operating Cost** | **$3,334** |

The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact to ocean water quality is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, power grid impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of produced water at Platform Harmony has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platform Harmony.

The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as MMS approval and the SBCAPCD permitting), may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES permit expiry date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *8.1.2.b Drilling Muds & Cuttings*

At Platform Harmony, all OBM and cuttings were injected or transported to shore for recycling. About 80 percent of the WBM and cuttings were discharged overboard between 2002 and 2003 with 20 percent injected. This alternatives feasibility study focuses on the portion of WBM and cuttings that is discharged overboard. In 2007, the operator predicts that 170,000 bbls of WBM will be discharged overboard. For 2008 through 2010, the annual average discharge of WBM and cuttings will be 112,500 bbls. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES permit limits of 200,000 and 40,000 bbls, respectively, which can be discharged at Platform Harmony.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill.

##### *8.1.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

When OBM is used for drilling, the drilling muds are separated from the cuttings on a “shale shaker”. The cleaned muds are recycled back to the drilling operation. The cuttings, with some OBM that is not separated, are transported to a slurry unit, where they are ground up, mixed with carrying fluid (typically seawater), viscosifier and inhibitors. The resulting slurry is delivered to a diesel triplex pump, and the cuttings slurry is injected into the annular space between the surface casing and the production casing of an existing permitted well. The cuttings must be ground to pass through a 20 mesh screen prior to pumping downhole.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and wellbores.

**Technological factors:** Fracture injection technology is in use on Platform Harmony but only for lower injection rates. Injection equipment is available. However, in order to inject all generated mud and cuttings, additional deck space would be required for material handling operations and injection equipment. The cost of fabrication and installation of this additional deck space is estimated to be $2 million. (This is in addition to the deck extension and costs for produced water injection.) A structural study would be required to determine if the platform can safely support such a deck extension.

The estimated annual average run time of injection pumps at Harmony from 2002 through 2003 was 294 hours to inject all OBM and 20 percent of the WBM and associated cuttings. In 2007, to inject 100 percent of WBM and cuttings would require an estimated 2,883 pump-hours. This is a 981 percent increase in injection pump run time (not including run time for OBM and cuttings). At least two injection pumps and related equipment would be required, and even then there is the potential that injection rates could not keep up with the WBM and cuttings generation rates in the shallower, larger hole diameter well intervals. Also, at least 2 injection wells would have to be utilized at once to handle the volumes, and one or more backup injection wells would have to be ready for the occasional injection upsets that occur.

The geologic formations must be suitable for fracture injection. Injecting the high volumes of WBM and cuttings could cause significant fracture propagation. This propagation could cause significant damage to geologic formations including the possibility of breaching to the seafloor. Formation evaluations have not been conducted for the large volumes that would require injection, if the overboard discharge of WBM and cutting is prohibited.

Field testing and modeling would be necessary before the technical feasibility of injection of 100 percent of the WBM and cuttings can be determined. For the above reasons, it is uncertain if injection of all WBM and cuttings is technically feasible.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil, oil-based or synthetic-based fluids, or toxic additives. Toxicity of the WBM is regulated by the NPDES General Permit. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are prevented from being discharged to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the additional injection equipment. The platform power is supplied by the state electricity grid; therefore the secondary environmental impacts resulting from the use of electric grinders would occur at the power generation plant. Also, there would be significant increased air emissions from operation of diesel pumps needed to inject drilling muds and cuttings. A comparison of the estimated increased annual emissions due to WBM and cuttings injection to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 8-4.

**Table 8-4**
**Comparison of Estimated Historical Annual WBM and Cuttings Drilling Injection Emissions, Estimated Incremental Increase in Emissions Due Discharge Prohibition, and Percent Increase in Emissions at Platform Harmony**

| Emission Constituent | Historical Estimated Average Annual Drilling Injection Emissions for 2000-2005 (tons/year) | Estimated Incremental Increase in Emissions Due To Injection of WBM and Cuttings (tons/year) | Estimated Percent Increase in Emissions |
|---|---|---|---|
| NOx | 1.6 | 14.9 | 931% |
| CO | 0.3 | 3.2 | 1066% |
| SOx | 0.1 | 1.1 | 1100% |
| ROG | 0.1 | 1.0 | 1000% |
| PM | 0.1 | 1.1 | 1100% |

The significant increase in air emissions to inject WBM and cuttings does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The significant increase in air emissions renders the environmental factor to WBM and cuttings injection as not feasible.

**Economic factors:** Capital costs to increase the amount of deck space are estimated at $3 million (costs are independent of those for produced water). The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to the ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from construction and injection operations and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Harmony has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and

SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *8.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. However the volumes are relatively small, at Platform Harmony, 2,928 bbls of OBM generated in 2003 were returned to shore for recycling. An estimated 4,000 bbls of OBM is predicted to be recycled annually from 2007 to 2010. The predicted WBM and cuttings volumes to be discharged in 2007 are 170,000 bbls, assuming 20 percent is disposed through injection. If this amount was to be transported to shore for disposal, instead of being discharged overboard, it would be an approximate increase in volume of 58 times the 2003 volume transported to shore.

**Technological factors:** A deck extension would be necessary to provide space for the large number of cuttings boxes required for the transport of mud and cuttings. The estimated cost for this deck extension is $2 million. A structural study would be required to determine if the platform can safely support such a deck extension.

There are no technological limits to the movement of drilling muds and cuttings to shore. The muds and cuttings are usually transported in cuttings boxes, each holding approximately 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. While large volumes, such as 170,000 bbls per year, may be transported more efficiently by barge, the use of barges is not considered a viable option due to air permit restrictions. Additional reasons include safety concerns around mooring the barge to the platform and the ability of the barge to safely remain on station during drilling operations occurring under adverse weather conditions.

Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 8.1.2.b.i; Environmental factors).

In addition, the incremental secondary impacts from air emissions would be significant. Emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill and from the equipment used to load and unload the supply vessels and trucks. An estimated 211 supply vessel trips would be required to transport 170,000 bbls of WBM and cuttings from Platform Harmony to the Pt. Hueneme. The number of truck trips to transport 170,000 bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be almost 3,700 truck trips, or approximately 14 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 87 tons of $NO_x$ and more than 16.9 tons of CO per year. Additional emissions would occur during loading and unloading operations from the supply vessels and trucks. Total increased $SO_x$ emissions would be approximately 9 tons per year. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 8-5.

**Table 8-5**
**Comparison of Estimated and Permitted Emissions at Platform Harmony**

| Emission Constituent | Total Annual Emissions for 2005 (tons/year) | Estimated Incremental Increase to Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 34.89 | 119 | 341% | 160.1 |
| CO | 17.41 | 41.3 | 237% | 82.5 |
| SOx | 5.78 | 8.7 | 150.5% | 82.6 |
| ROG | 39.88 | 10.2 | 25.5% | 55.4 |
| PM | 3.47 | 10.5 | 302.6% | 15.2 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The primary regulated pollutants of concern in Santa Barbara County are NOx and reactive organic gases (ROG). Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment. Permitting for the additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to the transportation of WBM and cuttings to shore for disposal as not feasible.

**Economic factors:** Substantial costs would be incurred by the operator to adopt this alternative. The estimated cost for a deck extension for mud and cuttings storage space is estimates at $6 million (costs are independent of those for produced water).

A typical supply boat charter is about $12,000 per day. The cost for 212 roundtrips of 24 hours each is approximately $2.5 million. Typical landfill disposal charges are $10-$20 per barrel with transportation costs of $2-$4 per barrel. Landfill disposal costs for 170,000 bbls could range from $2 million to $4 million. The total costs for onshore disposal would range from $4.5 million to $6.5 million ($26.47 to $38.23 per bbl), which is 88 to 127 times greater than the estimated costs of overboard discharge. The significant capital and operating costs for onshore disposal of WBM and cuttings make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to the increases in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity.

MMS regulates platform design. It is unknown if MMS would approve modifications to the platform.

The primary negative environmental impacts (increased air emissions and increased supply vessel and truck traffic) render the social factor to transportation of WBM and cuttings to shore for disposal as not feasible.

**Time factor:** Supply vessels are not readily available in southern California. ExxonMobil currently has only two supply boats under contract. The amount of time to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that are currently discharged overboard at Platform Harmony has been assessed for feasibility as an alternative disposal method.

Environmental factors such as increased air emissions at the platform during deck construction installation, and significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Uncertainty around the ability of the platform to physically support additional deck space in a safe manner leaves the technical feasibility in doubt.

With regard to economic factors an estimated cost increase of 88 to 127 times the costs of overboard discharge make this alternative uneconomical.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory considerations (such as MMS approval and SBCAPCD permitting) this alternative is considered infeasible.

The time required to procure additional supply vessels and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

## 8.2 PLATFORM HERITAGE

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Heritage. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM and associated cuttings are described.

### 8.2.1 Current practices

#### *8.2.1.a Produced Water*

The average annual volume of produced water generated at Platform Heritage was 5.8 million bbls from 2000 to 2006 and is estimated to be 12.3 million bbls from 2007 to 2010.

Total fluid production (an oil/produced water emulsion) from Platforms Harmony, Heritage, and Hondo is routed onshore via pipeline to ExxonMobil’s Las Flores Canyon (LFC) Facility. At LFC free oil is removed from the emulsion. Produced water from the inlet separation is routed to pressurized plate separators and media filters for removal of dispersed oil and solids. Hydrochloric acid is then injected into the water to facilitate removal of sulfur compounds in a Vacuum Flash Tower. The water is then routed through closed tanks for treatment by anaerobic bacteria to remove soluble organic compounds. The water is then routed to basins for aeration and final polishing by aerobic bacteria. After residence time in Clarifiers to facilitate the capture of inert and biological solids, the treated produced water is pumped offshore via pipeline to Harmony for overboard discharge.

The costs for the treatment and discharge of the produced water from Platforms Harmony, Heritage, and Hondo have been estimated to be about $2 million per year through 2006. The average annual produced water production rates for Platforms Harmony, Heritage, and Hondo are estimated at 13.7 million bbls per year (equivalent to approximately 1.6 million gallons per day). This is equivalent to a per barrel average cost of approximately $0.15 over the past five years with similar costs forecast through 2010.

#### *8.2.1.b Drilling muds and cuttings*

The average volumes of WBM, OBM, and associated cuttings are summarized in Table 8-6. From 2000 to 2006, the total volume of all muds and cuttings generated was estimated at 847,205 bbls, with WBM making up 74 percent of the total. Approximately 80 percent of the WBM and cuttings were discharged overboard at the platform, and the remaining 20 percent was injected. For OBM, 80 percent was injected, along with 100 percent of the associated cuttings. About 20 percent of the OBM was transported onshore for recycling. Although drilling plans are uncertain, between 2007 and 2010, the operator is planning to increase the WBM usage to approximately 150,000 bbls for the year. During that same period, the OBM usage will increase to 24,000 bbls annually. No changes are expected in the proportions of muds and cuttings that are discharged overboard, injected, and recycled when drilling.

The estimated 2000 through 2006 annual costs for injection of WBM and cuttings ranged from $9.58 to $24.21 per barrel. 2007 through 2010 projected annual costs for injection of WBM and cuttings is estimated to range from $12.10 to $14.01 per barrel. The estimated 2000 through 2006 annual cost of OBM and cuttings ranged from $48.94 to $153.56 per barrel. The 2007 through 2010 projected annual costs for injection of OBM and cuttings is estimated to range from $54.60 to $63.20 per barrel. Costs for overboard discharge of WBM and cuttings are not tracked by the operator. However, other operators with similar operations estimate a $0.30 per bbl cost for overboard discharge.

**Table 8-6**
**Drilling Muds & Cuttings Volumes Generated at Platform Heritage**

| Annual average (bbl/year) | 2000-2006 | 2007-2010 |
|---|---|---|
| Water Based Mud | 89,789 | 150,000 |
| WBM Cuttings | 11,972 | 20,000 |
| Oil Based Mud | 12,042 | 24,000 |
| OBM Cuttings | 4,817 | 8,000 |
| **Total** | **118,620** | **202,000** |

### 8.2.2 Alternatives to Discharge

#### *8.2.2.a Produced Water*

Although produced water from Platform Heritage, mixed with produced water from Platform Harmony and Platform Hondo, is transported to shore for treatment via pipeline, no onshore facilities are available with the capacity to accept the volume of produced water generated for disposal via injection (667,397 gallons per day for Heritage alone).

In 2007, the operator predicts that 10.2 million bbls of produced water generated at Platform Heritage will be discharged to the ocean. The 2007 through 2010 projected annual discharge volumes for produced water is below the allowable NPDES General Permit limit of 33,762,000 bbls that can be discharged from Platform Heritage (less any produced water volumes from Platforms Harmony and Hondo).

Because of the large volumes of produced water generated at Platform Heritage, only one method has been identified as being a potentially feasible alternative to the overboard discharge of produced water, which is injection back into the hydrocarbon formation or into suitable surrounding strata that can accept the produced water generated. To change operations at Platform Heritage to injection all produced water generated, the following equipment and support facilities would be required:

- Treatment equipment to change from a 2-phase separation system to a 3-phase separation system. Currently, the gas phase is separated from the reservoir fluids, and the remaining oil/water emulsion is sent to shore for further treatment. For injection on the platform the produced water would need to be separated from the emulsion before injection. Three phase separation at Platform Heritage would be complicated due to scaling issues resulting from the incompatibility of waters produced from different reservoirs.
- One deck extension to accommodate the additional treatment and pumping equipment. In addition, a structural engineering study would be required to determine if it is feasible for the existing platform structure to support the additional extension and equipment.
- Injection pumps and piping and fittings.
- Additional power to run the treatment systems and injection pumps.
- Engineering design for the additional deck extension and equipment to be installed.
- Drilling of three new injector wells.

**Technological factors:** Injection technology is in use to a limited extent on other platforms in the area. All equipment is readily available although lead times for procurement of some equipment may be significant (24-36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, permeability, porosity, and geological structure may limit the injection rates and total capacity. In addition, water from different production reservoirs must be compatible. The main potential problem associated with water incompatibility is scale and precipitate formation. It is known that water incompatibility occurs at Platform Heritage.

Field testing and reservoir modeling would be required before the technical feasibility of injection of 100 percent of the produced water could be determined. At the present time, it is uncertain if injection of 100 percent of the produced water is technologically feasible.

**Environmental factors:** The current discharge of Platform Heritage produced water at Platform Harmony complies with water quality discharge limitations contained in NPDES General Permit. The discharge occurs in the open ocean in approximately 1,200 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor. All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100 m mixing zone (MMS 2001a & 2001b).

If overboard discharge of produced water was prohibited, additional power would be required to run the necessary water treatment equipment and injection pumps. Since the power would come from the onshore electricity grid, the associated secondary environmental impacts (additional air emissions) would be at the point of power generation. In addition, the risk of leaks and spills of oil and untreated produced water would increase because of the additional piping, valves, and treatment vessels required for the treatment and separation systems and the injection pumping systems. Environmental considerations make injection of 100 percent of the produced water not feasible.

**Economic factors:** Significant capital costs and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. The average annual volume of produced water to be treated and injected is high, 5.6 million bbls per year, requiring large capacity treatment systems and pumps to handle the volume as well as to maintain adequate pumping equipment redundancy and performance reliability. The available deck space on the platform is inadequate, requiring additional construction.

The operator prepared a screening level cost estimate for the purchase and installation of the major equipment required for injection. The cost estimate is broken down into major components, design and construction, and drilling costs (Table 8-7). The cost for procurement and installation of the treatment and injection system is estimated at approximately $31.5million with an additional cost to prepare four injection wells at approximately $30 million for a total capital expenditure of approximately $61.5 million.

**Table 8-7**
**Capital Costs for Injection Equipment & Installation at Platform Heritage**

| Platform Heritage Equipment & Installation Items | Cost ($'000s) |
|---|---|
| 3-Phase Separation System Installation | $18,323 |
| 1 Deck Extension | $750 |
| System Piping and Fittings | $1,680 |
| Injection Pumps (900 hp) | $5,040 |
| Construction of Motor Control Center Buildings | $1,000 |
| Engineering Design | $1,383 |
| Contingency Costs (15 percent) | $3,302 |
| **Total Platform Facilities Installation Cost** | **$31,478** |
| | |
| Number of Existing Wells to be Converted to Injection | 0 |
| Number of New Wells to Drill | 3 |
| Drilling Costs | $30,000 |
| **Total Costs for Drilling & Facilities** | **$61,478** |

Note: - The costs presented do not include lost revenue due to production downtime for retrofitting separators and completing tie-ins to existing systems.

Screening level operating costs for the treatment and injection system were calculated by the operator and are presented in Table 8-8. The major components of the operating costs are:

- Electrical power (supplied via submarine cable from the onshore electricity grid), operations, and maintenance for the 4,200 hp centrifugal pumps.
- Costs for consumable chemicals, required for the 3-phase treatment system to separate the oil and emulsion from the produced water before injection.

The estimated annual average operating costs are $9.4 million.

**Table 8-8**
**Operating Costs for Treatment and Injection of Produced Water at Platform Heritage**

| Platform Harmony Injection Operations Costs | Cost ($'000s /year) |
|---|---|
| Electrical - Pumps only | $2,745 |
| Electrical - Auxiliary and Control Systems | $549 |
| Chemical Costs for 3-pahse separation treatment | $6,077 |
| **Total Operating Cost** | **$9,371** |

The significant capital and operating costs for produced water injection are prohibitive and make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact to ocean water quality is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emission in support of construction activities). Also public response to increased air emissions and power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, power grid impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months need to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the Platform Heritage produced water that is currently discharged overboard has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, field testing and reservoir modeling would be required to determine the feasibility of 100 percent injection at Platform Heritage.

Economic factors of an estimated $61.5 million for the purchase, construction, and installation of equipment and an additional $9.3

million per year in operating costs make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as MMS approval and SBCAPCD permitting), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *8.2.2.b Drilling Muds & Cuttings*

At Platform Heritage, all OBM and associated cuttings were injected or transported to shore for recycling. From 2000 through 2006 approximately 80 percent of the WBM and cuttings have been discharged overboard 20 percent have been injected. This alternatives feasibility study focuses on the portion of WBM and cuttings that is discharged overboard. From 2007 to 2010, the annual average of WBM and cuttings discharged overboard is estimated to be 136,000 bbls each year. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 200,000 and 40,000 bbls, respectively, which can be discharged at Platform Heritage.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill.

##### *8.2.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling fluids and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling fluids and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

When OBM is used for drilling, the drilling muds are separated from the cuttings on “shale shakers”. The cleaned muds are recycled back to the drilling operation and the cuttings, with some OBM that is not separated, are transported to a slurry unit, where they are ground up, mixed with carrying fluid (typically seawater), viscosifier and inhibitors. The resulting slurry is delivered to a diesel triplex pump, and the cuttings slurry is injected into the annular space between the surface casing and the production casing of an existing permitted well. The cuttings must be ground to pass through a 20 mesh screen prior to pumping downhole.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM mud and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment, and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and wellbores.

**Technological factors:** Fraction injection technology is in use on Platform Heritage but only for lower injection rates. Injection equipment is available. However, in order to inject all generated mud and cuttings, additional deck space would be required for material handling operations and injection equipment. The cost of fabrication and installation of this additional deck space is estimated to be $2 million. (This is in addition to the deck extension and costs for produced water injection.) A structural study would be required to determine if the platform can safely support such a deck extension.

The estimated annual average run time of injection pumps at Platform Heritage from 2000 through 2005 was 339 hours to inject all OBM and 20 percent of the WBM and associated cuttings. In 2007, to inject 100 percent of WBM and cuttings would require an estimated 2,267 pump-hours. This is approximately a 689 percent increase in injection pumping time (not including the injection pump run time for OBM and cuttings). At least two injection pumps and related equipment would be required, and even then there is the potential that injection rates could not keep up with the WBM and cuttings generation rates in the shallower, larger hole diameter well intervals. Also, at least two injection wells would have to be utilized at once to handle the volumes, and one or more backup injection wells would have to be ready for the occasional injection upsets that occur.

The geologic formations must be suitable for fracture injection. Injecting the high volumes of WBM and cuttings could cause significant fracture propagation. This propagation could cause significant damage to geologic formations including the possibility of breaching to the seafloor. Formation evaluations have not been conducted for the large volumes that would require injection, if the overboard discharge of WBM and cutting is prohibited.

Field testing and modeling would be necessary before the technical feasibility of injection of 100 percent of the WBM and cuttings can be determined. For the above reasons, it is uncertain if injection of all WBM and cuttings is technically feasible.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil, oil-based or synthetic-based fluids, or toxic additives. Toxicity of the WBM is regulated by the NPDES General Permit. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Therefore, ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are prevented from being discharged to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the additional injection equipment. The platform power is supplied by the state electricity grid; therefore the secondary environmental impacts resulting from the use of electric grinders would occur at the power generation plant. Also, there would be significant increased air emissions from operation of diesel pumps needed to inject drilling muds and cuttings. A comparison of the estimated increased annual emissions due to WBM and cuttings injection to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 8-9.

**Table 8-9**
**Comparison of Estimated Historical Annual WBM and Cuttings Drilling Injection Emissions, Estimated Incremental Increase in Emissions Due Discharge Prohibition, and Percent Increase in Emissions at Platform Heritage**

| Emission Constituent | Historical Estimated Average Annual Drilling Injection Emissions for 2000-2005 (tons/year) | Estimated Incremental Increase in Emissions Due To Injection of WBM and Cuttings (tons/year) | Estimated Percent Increase in Emissions |
|---|---|---|---|
| NOx | 1.8 | 11.9 | 661% |
| CO | 0.4 | 2.6 | 650% |
| SOx | 0.1 | 0.9 | 900% |
| ROG | 0.1 | 0.8 | 800% |
| PM | 0.1 | 0.8 | 800% |

The significant increase in air emissions to dispose of WBM and cuttings does not appear environmentally sound given the minimal seafloor impact from the WBM and cuttings. The significant increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Capital costs to increase the amount of deck space are estimated at $3 million (costs are independent of those for produced water). The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to the ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from construction and injection operations and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and

SBCAPCD permitting) renders the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Heritage has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *8.2.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. However, the volumes are relatively small. At Platform Heritage, about 20 percent of the annual average of 12,042 bbls of OBM was returned to shore for recycling. The volume to be recycled in 2006 is estimated at 4,250 bbls, and 4,000 bbls are predicted to be recycled annually from 2007 to 2010. The predicted total volume of WBM and associated cuttings requiring disposal in 2007 is 170,000 bbls, of which 80 percent is estimated to be discharged overboard and 20 percent is estimated to be injected. If 136,000 bbls (80 percent of 170,000) were transported to shore for disposal instead of being discharged overboard, it would be an approximate increase of approximately 40 times the 2006 volume transported to shore.

**Technological factors:** A deck extension would be necessary to provide space for the large number of cuttings boxes required for the transport of WBM and cuttings. The estimated cost for this deck extension is $6 million. A structural study would be required to determine if the platform can safely support such a deck extension.

There are no technological limits to the movement of drilling muds and cuttings to shore. The muds and cuttings are usually transported in cuttings boxes, each holding approximately 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. While large volumes, such as 136,000 bbls per year (80 percent of the 2007 WBM and cuttings volume), may be transported more efficiently by barge, the use of barges is not considered a viable option due to air permit restrictions. Additional reasons include safety concerns around mooring the barge to the platform and the ability of the barge to safely remain on station during drilling operations occurring under adverse weather conditions.

Transportation of WBM and cuttings to shore is technologically feasible. However, MMS regulates platform design. It is unknown if MMS would approve modifications to the platform.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 8.2.2.b.i; Environmental factors).

In addition, the incremental secondary impacts from air emissions would be significant. Emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill and from the equipment used to load and unload the supply vessels and trucks. An estimated 169 supply vessel trips would be required to transport 136,000 bbls of WBM and cuttings from the Platform Heritage to the Pt. Hueneme. The number of truck trips to transport 136,000 bbls of WBM and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be almost 2,957 truck trips, or approximately 11 trucks per day for one year (based on 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 74 tons of $NO_x$ and 25 tons of CO per year. Additional small emissions would occur during unloading operations from the supply vessels and trucks. Total increased $SO_x$ emissions are estimated at 7.8 tons per year. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 8-10.

**Table 8-10**
**Comparison of Current, Estimated, and Permitted Emissions at Platform Heritage**

| Emission Constituent | Total Annual Emissions for 2005 (tons/year) | Estimated Incremental Increase to Annual Emissions Due To Transportation of WBM and Cuttings to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 39.34 | 105 | 266.9% | 160.1 |
| CO | 22.61 | 35.9 | 158.8% | 82.5 |
| SOx | 13.14 | 7.8 | 59.4% | 82.6 |
| ROG | 45.05 | 9.1 | 20.2% | 55.4 |
| PM | 4.18 | 9.4 | 224.9% | 15.2 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The primary regulated pollutants of concern in Santa Barbara County are NOx and ROG. Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment. Permitting for additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to WBM and cuttings transportation to shore as not feasible.

**Economic factors:** Substantial costs would be incurred by the operator to adopt this alternative. The estimated cost for a deck extension for mud and cuttings storage space is estimated at $2 million.

A typical supply boat charter is about $12,000 per day. The cost for 169 roundtrips of 24 hours each is approximately $2.2 million. Typical landfill disposal charges are $10-$20 per barrel with transportation costs of $2-$4 per barrel. Truck transportation and landfill disposal costs for 136,000 bbls could range from $1.6 million to $3.3 million. The total costs for onshore disposal would range from $3.8 million to $5.5 million ($27.94 to $40.44), which is 93 to 135 times greater than the costs of overboard discharge. The significant capital and operating costs for onshore disposal of WBM and cuttings make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to the increase in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity.

MMS regulates platform design. It is unknown if MMS would approve modifications to the platform.

The primary negative environmental impacts (increased air emissions and increased vessel and truck traffic) render the social factor to transportation of WBM and cuttings to shore for disposal as not feasible.

**Time factor:** Supply vessels are not readily available in southern California. ExxonMobil currently has only two supply vessels under contract. The amount of time to procure new supply vessels and to obtain permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that are currently discharged overboard at Platform Heritage has been assessed for feasibility as an alternative disposal method.

Environmental factors such as increased air emissions at the platform during deck construction installation, and significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Uncertainty around the ability of the platform to physically support additional deck space in a safe manner leaves the technical feasibility in doubt.

With regard to economic factors an estimated cost increase of 93 to 135 times the costs of overboard discharge make this alternative uneconomical.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) this alternative is considered infeasible.

The time required to procure additional supply vessels and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

## 8.3 PLATFORM HONDO

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Hondo. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM and associated cuttings are described.

### 8.3.1 Current practices

#### *8.3.1.a Produced Water*

The average annual volume of produced water generated at Platform Hondo was 2.5 million bbls from 2000 to 2006 and is estimated to be 2.4 million bbls from 2007 to 2010.

Total fluid production (an oil/produced water emulsion) from Platforms Harmony, Heritage, and Hondo is routed onshore via pipeline to ExxonMobil’s Las Flores Canyon (LFC) Facility. At LFC free oil is removed from the emulsion. Produced water from the inlet separation is routed to pressurized plate separators and media filters for removal of dispersed oil and solids. Hydrochloric acid is then injected into the water to facilitate removal of sulfur compounds in a Vacuum Flash Tower. The water is then routed through closed tanks for treatment by anaerobic bacteria to remove soluble organic compounds. The water is then routed to basins for aeration and final polishing by aerobic bacteria. After residence time in Clarifiers to facilitate the capture of inert and biological solids, the treated produced water is pumped offshore via pipeline to Platform Harmony for overboard discharge.

The costs for the treatment and discharge of the produced water from Platforms Harmony, Heritage, and Hondo have been estimated to be about $2 million per year through 2006. The average annual produced water production rates for Platforms Harmony, Heritage, and Hondo are estimated at 13.7 million bbls per year (equivalent to approximately 1.6 million gallons per day). This is equivalent to a per barrel average cost of approximately $0.15 over the past five years with similar costs forecast for through 2010.

#### 8.3.1.b Drilling muds and cuttings

The average volumes of WBM, OBM, and associated cuttings are summarized in Table 8-11. From 2000 to 2004, the total volume of all muds and cuttings generated was estimated at 72,943 bbls, with WBM making up approximately 81 percent of the total. One-hundred percent of the WBM and cuttings were discharged overboard at the platform. Between 2000 through 2004 approximately 41 percent (1,500 bbls per year) of the total volume of OBM was transported to shore for recycling. The remaining 59 percent of the OBM and 100 percent of the oil-based cuttings were injected.

Although drilling plans are uncertain no drilling activity is scheduled for 2007, and from 2008 through 2010 WBM and cuttings are projected to be increased to approximately 85,000 bbls annually and OBM and cuttings are projected to be increased to approximately 20,000 bbls annually. No changes are expected in the proportions of muds and cuttings that are discharged overboard, injected, and recycled when drilling.

WBM and cuttings were generated between 2000 and 2004. OBM and cuttings were generated between 2000 and 2004. Costs for overboard discharge of WBM and cuttings are not tracked by the operator. However, other operators with similar operations estimate a $0.30 per bbl cost for overboard discharge.

**Table 8-11**
**Drilling Muds & Cuttings Volumes Generated at Platform Hondo**

| Annual average (bbl/year) | 2000-2006* | 2007 | 2008-2010 |
|---|---|---|---|
| Water Based Mud | 15,122 | 0 | 75,000 |
| WBM Cuttings | 2,016 | 0 | 10,000 |
| Oil Based Mud | 3,619 | 0 | 15,000 |
| OBM Cuttings | 1,080 | 0 | 5,000 |
| **Total** | **10,420** | **0** | **105,000** |

*For years when drilling occurred and WBM and OBM were used.

### 8.3.2 Alternatives to Discharge

#### 8.3.2.a Produced Water

Although produced water from Platform Hondo, mixed with produced water from Platform Harmony and Platform Heritage, is transported to shore for treatment via pipeline, no onshore facilities are available with the capacity to accept the volume of produced water generated for disposal via injection (286,520 gallons per day for Hondo alone).

For 2007 through 2010 the operator projects that an annual average of volume of 2.4 million bbls of produced water generated at Platform Hondo will be discharged to the ocean at Platform Harmony. The 2007 through 2010 projected annual discharge volumes for produced water is below the allowable NPDES General

Permit limit of 33,762,000 bbls (less any produced water volumes discharged form Platforms Harmony and Heritage) that can be discharged from Platform Hondo.

Because of the large volumes of produced water generated at Platform Hondo, only one method has been identified as being a potentially feasible alternative to the overboard discharge of produced water at Platform Hondo, which is injection back in to the hydrocarbon formation or into suitable surrounding strata that can accept the produced water generated. To change operations at Platform Hondo to support injection of all produced water generated, the following equipment and support facilities would be required:

- Treatment equipment to change from a 2-phase separation system to a 3-phase separation system. Currently, after the gas phase is separated from the reservoir fluids, the remaining oil/water emulsion is sent to shore for further treatment. For injection on the platform the produced water would be separated from the oil/water emulsion before injection.
- One deck extension to accommodate the additional treatment and pumping equipment. In addition, a structural engineering study would be required to determine if it is feasible for the existing platform structure to support the additional extension and equipment.
- Injection pumps and piping and fittings.
- Additional power to run the treatment systems and injection pumps.
- Engineering design for the additional deck extension and equipment to be installed.
- Drilling of a new injector well and conversion of three existing wells to injection wells.

**Technological factors:** Injection technology is in use to a limited extent on other platforms in the area. All equipment is readily available although lead times for procurement of some equipment may be significant (24-36 months). Equipment installation cannot be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. In addition, water from different production reservoirs must be compatible.. The main potential problem associated with water incompatibility is scale formation and precipitate.

Field testing and reservoir modeling results would be required before the technical feasibility of injection of 100 percent of the produced water could be determined. At the present time, it is uncertain if injection of 100 percent of the produced water is technologically feasible at Platform Hondo.

**Environmental factors:** The current discharge of Platform Hondo produced water at Platform Harmony complies with water quality discharge limitations contained in NPDES General Permit. The discharge occurs in the open ocean in approximately 1,200 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor. All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100 m mixing zone (MMS 2001a & 2001b).

If overboard discharge of produced water was prohibited, additional power would be required to run the necessary water treatment equipment and injection pumps. Since the power would come from the onshore electricity grid, the associated secondary environmental impacts (additional air emissions) would be at the point of power generation. In addition, the risk of leaks and spills of oil and untreated produced water would increase because of the additional piping, valves, and treatment vessels required for the treatment and separation systems and the injection pumping systems. Environmental considerations make injection of 100 percent of the produced water not feasible.

**Economic factors:** Significant capital costs and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. The volume of produced water to be treated and injected is high, 2.4 million bbls per year, requiring large capacity treatment systems and pumps to handle the volume as well as to maintain adequate pumping redundancy and performance reliability. The available deck space on the platform is inadequate, requiring additional construction.

The operator prepared a screening level cost estimate for the purchase and installation of the major equipment required for injection. The cost estimate is broken down into major components, design and construction, and drilling costs). The cost for procurement and installation the treatment and injection system is estimated at approximately $12.4 million with an additional cost to prepare four injection wells of approximately $10 million for a total capital expenditure of approximately $22.4 million (Table 8-12).

**Table 8-12**
**Capital Costs for Injection Equipment & Installation at Platform Hondo**

| Platform Hondo Equipment & Installation Items | Cost ($'000s) |
|---|---|
| 3-Phase Separation System Installation | $7,433 |
| 1 Deck Extension | $750 |
| System Piping and Fittings | $200 |
| Injection Pumps (900 hp) | $600 |
| Construction of Motor Control Center Buildings | $1,000 |
| Engineering Design | $495 |
| Contingency Costs (15%) | $1,898 |
| **Total Platform Facilities Installation Cost** | **$12,375** |
| | |
| Number of Existing Wells to be Converted to Injection | 3 |
| Number of New Wells to Drill | 1 |
| Drilling Costs | $10,000 |
| **Total Costs for Drilling & Facilities** | **$22,375** |

Note: - The costs presented do not include lost revenue due to production downtime for retrofitting separators and completing tie-ins to existing systems.

Screening level operating costs for the treatment and injection system were calculated by the operator and are presented in Table 8-13. The major components of the operating costs are:

- Electrical power (supplied via submarine cable from the onshore electricity grid), operations, and maintenance for the 500 hp centrifugal pumps.
- Costs for consumable chemicals, required for the 3-phase treatment system to separate the oil and emulsion from the produced water before injection.

The estimated annual average operating costs are $1.9 million.

**Table 8-13**
**Operating Costs for Treatment and Injection of Produced Water at Platform Hondo**

| Platform Hondo Injection Operations Costs | Cost ($'000s /year) |
|---|---|
| Electrical - Pumps only | $327 |
| Electrical - Auxiliary and Control. Systems | $65 |
| Chemical Costs for 3-pahse separation treatment | $1,478 |
| **Total Operating Cost** | **$1,870** |

The significant capital and operating costs for produced water injection are prohibitive and make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact to ocean water quality is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the Platform Hondo produced water that is currently discharged overboard has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, field testing and reservoir modeling would be required to determine the feasibility of 100 percent injection at Platform Hondo.

Economic factors of an estimated $22.4 million for the purchase, construction, and installation of equipment and an additional $1.9 million per year in operating costs make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as MMS approval and SBCAPCD permitting), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years.

While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *8.3.2.b Drilling Muds & Cuttings*

At Platform Hondo, all OBM and associated cuttings were injected or transported to shore for recycling. All of the WBM and cuttings have been discharged overboard. In 2007, the operator predicts that there will be no WBM and cuttings discharged overboard. From 2008 to 2010, the volume for ocean discharge is estimated to be 85,000 bbls of WBM and cuttings each year. These projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 200,000 and 40,000 bbls, respectively, which can be discharged at Platform Hondo.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill.

##### *8.3.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection, in that drilling fluids and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling fluids and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

When OBM is used for drilling, the drilling muds are separated from the cuttings on a “shale shaker”. The cleaned muds are recycled back to the drilling operation. The cuttings, with some OBM that is not separated, are transported to a slurry unit, where they are ground up, mixed with carrying fluid (typically seawater), viscosifier and inhibitors. The resulting slurry is delivered to a diesel triplex pump, and the cuttings slurry is injected into the annular space between the surface casing and the production casing of an existing permitted well. The cuttings must be ground to pass through a 20 mesh screen prior to pumping downhole.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment, and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and wellbores.

**Technological factors:** Fraction injection technology is in use on Platform Hondo but only for lower injection rates. Injection equipment is available. However, in order to inject all mud and cuttings generated, additional deck space would be required for handling and injection equipment. The cost of fabrication and installation of this additional deck space is estimated to be $4 million. (This is in addition to the deck extension and costs for produced water injection.) A structural study would be required to determine if the platform can safely support the additional deck space.

The estimated annual average run time of injection pumps at Platform Hondo from 2000 through 2004 was 57 hours to inject 59 percent of OBM and 100 percent of the oil-based cuttings. In 2007, to inject 100 percent of WBM and cuttings would require an estimated 1,133 pump-hours. This is an approximate 1,920 percent increase in injection pump run time (not including injection pump run time for OBM and cuttings). At least two injection pumps and related equipment would be required, and even then there is the potential that injection rates could not keep up with the WBM and cuttings generation rates in the shallower, larger hole diameter well intervals. Also, at least 2 injection wells would have to be utilized at once to handle the volumes, and one or more backup injection wells would have to be ready for the occasional injection upsets that occur.

The geologic formations must be suitable for fracture injection. Injecting the high volumes of WBM and cuttings could cause significant fracture propagation. This propagation could cause significant damage to geologic formations including the possibility of breaching to the seafloor. Formation evaluations have not been conducted for the large volumes that would require injection, if the overboard discharge of WBM and cutting is prohibited.

Field testing and modeling results would be necessary before the technical feasibility of injection of 100 percent of the WBM and cuttings can be determined. For the above reasons, it is uncertain if injection of all WBM and cuttings is technically feasible.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil, oil-based or synthetic-based fluids, or toxic additives. Toxicity of the WBM is regulated by the NPDES General Permit. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Therefore, ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are prevented from being discharged to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the additional injection equipment. The platform power is supplied by the state electricity grid; therefore the secondary environmental impacts resulting from the use of electric grinders would occur at the power generation plant. Also, there would be significant increased air emissions from operation of diesel pumps needed to inject drilling muds and cuttings. A comparison of the estimated increased annual emissions due to WBM and cuttings injection to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 8-14.

**Table 8-14**
**Comparison of Estimated Historical Annual WBM and Cuttings Drilling Injection Emissions, Estimated Incremental Increase in Emissions Due Discharge Prohibition, and Percent Increase in Emissions at Platform Hondo**

| Emission Constituent | Historical Estimated Average Annual Drilling Injection Emissions for 2000-2005 (tons/year) | Estimated Incremental Increase in Emissions Due To Injection of WBM and Cuttings (tons/year) | Estimated Percent Increase in Emissions |
|---|---|---|---|
| NOx | 0.3 | 6.0 | 2,000% |
| CO | 0.1 | 1.3 | 1,300% |
| SOx | 0.02 | 0.4 | 2,000% |
| ROG | 0.02 | 0.4 | 2,000% |
| PM | 0.02 | 0.4 | 2,000% |

The significant increase in air emissions to inject WBM and cuttings does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The significant increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors**: Capital costs to increase the amount of deck space are estimated at $6 million (costs are independent of those for produced water). The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from construction and injection operations and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) renders the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Hondo has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

*8.3.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. However, the volumes are relatively small. For example, at Platform Hondo, 6,000 bbls of all of the OBM generated between 2000 and 2004 were transported to shore for recycling. No WBM or cuttings are projected to be generated in 2007. The projected annual volume WBM and associated cuttings requiring disposal for 2008 through 2010 is 85,000 bbls. If 85,000 bbls of WBM and cuttings were transported to shore for disposal instead of being discharged overboard, it would be an approximate increase in volume transported to shore by 57 times the 2000 to 2004 average annual volume transported to shore.

**Technological factors:** A deck extension would be required to provide space for the large number of cuttings boxes required for the transport of WBM and cuttings. The estimated cost for this project is $4 million. A structural study would be required to determine if the platform can safely support the deck extensions.

There are no technological limits to the movement of drilling muds and cuttings to shore. The WBM and cuttings are usually transported in cuttings boxes, each holding approximately 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. While large volumes, such as the 85,000 bbls per year, may be transported more economically by barge, the use of barges is not considered a viable option due to air permit restrictions. Additional reasons include safety concerns around mooring the barge to the platform and the ability of the barge to safely remain on station during drilling operations occurring under adverse weather conditions.

Transportation of WBM and cuttings to shore is technologically feasible. However, MMS regulates platform design. It is unknown if MMS would approve modifications to platform design.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 8.3.2.b.i; Environmental factors).

In addition, the incremental secondary impacts from air emissions would be significant. Emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks. An estimated 106 supply vessel trips would be required to transport 85,000 bbls of WBM and cuttings from Platform Hondo to Pt. Hueneme. The number of truck trips to transport 85,000 bbls of WBM and cuttings from Pt. Hueme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be approximately 1,849 truck trips, or approximately 7 trucks per day for one year (based on a 5-day/week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 42 tons of $NO_x$ and 14.7 tons of CO per year. Additional small emissions would occur during unloading operations from the supply vessels and trucks. Total increased $SO_x$ emissions are estimated at 5.3 tons per year. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 2005) and the total permitted platform emission is presented in Table 8-15.

**Table 8-15**
**Comparison of Estimated and Permitted Emissions at Platform Hondo**

| Emission Constituent | Total Annual Platform Emissions for 2005 (tons/year) | Estimated Incremental Increase to Annual Emissions Due To Transportation of WBM and Cuttings to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Platform Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 35.89 | 67 | 186.7% | 160.1 |
| CO | 13.30 | 23.8 | 178.9% | 82.5 |
| SOx | 13.09 | 5.3 | 40.5% | 82.6 |
| ROG | 55.98 | 6.3 | 11.3% | 55.4 |
| PM | 3.48 | 6.3 | 181% | 15.2 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The primary regulated pollutants of concern in Santa Barbara County are NOx and ROG. Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment. Permitting for additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to WBM and cuttings transportation to shore as not feasible.

**Economic factors:** Substantial costs would be incurred by the operator to adopt this alternative. The estimated cost for a deck extension is estimated at $4 million.

A typical supply boat charter is about $12,000 per day. The cost for 106 roundtrips of 24 hours each is approximately $1.27 million. Barging the muds and cuttings to shore would be cheaper. Typical landfill disposal charges are $10-$20 per barrel with transportation costs of $2-$4 per barrel. Landfill disposal costs for 85,000 bbls could range from $1.02 million to $2.3 million. The total costs for onshore disposal would range from $2.3 million to $3.3 million ($27.06 to $38.82 per bbl), which is 90 to 129 times greater than the estimated per bbl cost of overboard discharge. The significant capital and operating costs for onshore disposal of WBM and cuttings make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to the increase in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity.

MMS regulates platform design. It is unknown if MMS would approve modifications to the platform.

The primary negative environmental impacts (increased air emissions and increased vessel and truck traffic) render the social factor to transportation of WBM and cuttings to shore for disposal as not feasible.

**Time factor:** Supply vessels are not readily available in southern California. ExxonMobil currently has only two supply vessels under contract. The amount of time to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that are currently discharged overboard at Platform Hondo has been assessed for feasibility as an alternative disposal method.

Environmental factors such as increased air emissions at the platform during deck construction installation, and significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Uncertainty around the ability of the platform to physically support additional deck space in a safe manner leaves the technical feasibility in doubt.

With regard to economic factors an estimated cost increase of 90 to 129 times the costs of overboard discharge make this alternative uneconomical.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) make this alternative infeasible.

The time required to procure additional supply vessels and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

# 9.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS – PACIFIC OPERATORS OFFSHORE LLC (POOLLC)

## 9.1 PLATFORMS HOGAN AND HOUCHIN

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platforms Hogan and Houchin. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 9.1.1 Current practices

All produced water from Platform Houchin is routed to Platform Hogan prior to shipment to shore for treatment. The feasibility analysis presented herein addresses the commingled volumes of produced water, drilling muds, and drill cuttings generated at both Platforms Hogan and Houchin.

#### *9.1.1.a Produced Water*

The combined average annual volume of produced water generated at Platforms Hogan and Houchin for 2000 through 2005 was 1.25 million bbls (equivalent to approximately 143,836 gallons per day). An average annual volume of 0.87 million bbls of produced water is forecast for 2006 through 2010.

Total fluid production (an oil/produced water emulsion), from Platforms Hogan and Houchin is routed onshore via pipeline to POOLLC's La Conchita oil and gas plant in Ventura County. The only processing performed on Platforms Hogan and Houchin is the separation of the produced fluids and gas into separate streams. There is no oil/water separation on Platforms Hogan and Houchin. Upon treatment onshore, produced water is pumped offshore via sub-sea pipeline to Platform Hogan for overboard discharge.

The costs for the treatment and discharge of produced water from Platforms Hogan and Houchin have been estimated to be $0.25 per bbl for 2000 through 2005. Similarly, produced water treatment and discharge costs are forecast at $0.25 per bbl for 2007 through 2010.

#### *9.1.1.b Drilling muds and cuttings*

WBM and cuttings were generated at Platform Hogan from 2000 to 2006. Average, annual, and projected volumes of WBM and cuttings are summarized in Table 9-1. Between 2000 and 2006, a total volume of approximately 6,252 bbls of WBM and drill cuttings were generated from Platform Hogan; no WBM and cuttings were generated from Platform Houchin. Approximately 60 percent of the WBM and cuttings were discharged overboard at the platform and the remaining 40 percent was shipped to shore for treatment at an operator-owned treatment facility.

Between 2007 and 2009 the operator plans to drill and generate WBM and cuttings from Platform Houchin. There are no plans to drill at Platform Hogan. In 2007, the operator is projected to generate 9,600 bbls of WBM and cuttings. For 2008 and 2009, the annual volume of WBM and cuttings is projected at 14,400 bbls per year. For 2007 through 2009 all WBM and cuttings that do not pass the sheen test are to be transported to shore for treatment at an operator-owned treatment facility. Remaining volumes of WBM and cuttings will be discharged overboard. No drilling is planned and no WBM is projected to be utilized in 2010.

The estimated costs for onshore treatment of WBM, that do not meet the sheen test, is $40 per bbl, for landfill disposal is $167 per bbl, and for onshore treatment of water-based drill cuttings is $100 per bbl.

**Table 9-1**
**Drilling Muds & Cuttings Volumes Generated at Platforms Hogan and Houchin**

| Annual average (bbl/year) | 2000-2006 (Hogan) | 2007 (Houchin) | 2008-2009 (Houchin) | 2010 (Hogan & Houchin) |
|---|---|---|---|---|
| Water Based Mud | 594 | 5,600 | 8,400 | 0 |
| WBM Cuttings | 299 | 4,000 | 6,000 | 0 |
| **Total** | **893** | **9,600** | **14,400** | **0** |

### 9.1.2 Alternatives to Discharge

#### *9.1.2.a Produced Water*

Produced water from Platforms Hogan and Houchin are commingled at Platform Hogan and transported to shore for treatment via sub-sea pipeline. However, there are no available onshore facilities with the capacity to accept the volume of produced water generated (1,250,000 bbls/year; 143,836 gallons/day) for disposal via onshore injection.

For 2007 through 2010 the operator predicts 891,549 bbls of produced water generated at Platforms Hogan and Houchin will be discharged to the ocean. The projected average annual produced water discharge volumes are below the allowable NPDES General Permit limit of 13,900,000 bbls per year that can be discharged for both Platforms Hogan and Houchin.

Offshore injection into the hydrocarbon formation or suitable surrounding strata that can accept the produced water has been identified as the only potentially feasible alternative to the overboard discharge of produced water at Platforms Hogan and Houchin. Based on responses from operators, additional equipment, perhaps structural enhancements to the platform work decks, and support facilities are required to facilitate the reinjection of all produced water generated. The following issues would need consideration:

- One deck extension to accommodate the additional treatment and pumping equipment. In addition, a structural engineering study would be required to determine if it is feasible for the existing platform structure to support the additional extension, pumps, piping, and equipment that would be required.

- Engineering design and procurement of injection pumps, filters, equipment, piping, and fittings required.

- Additional power to run the treatment systems and injection pumps.

- Engineering design for additional deck extensions and equipment to be installed.

- Drilling of new injector wells and conversion of existing wells to injection wells.

**Technological factors:** Injection technology is in limited use on other platforms in the area. All equipment is readily available although lead time for procurement of some equipment may be significant (estimated at 24 to 36 months). Equipment installation can not be accomplished without extensive fabrication of additional deck space. A structural study would be required to determine if the platform can safely support such a deck extension.

The geology of the production formations must be suitable for injection rates necessary to match the produced water generation rates. Reservoir characteristics, such as pressures, porosity, permeability, and geological structure may limit the injection rates and total capacity. In addition, water from different production reservoirs must be compatible. The main potential problem associated with water incompatibility is scale and precipitate formation. Injection evaluation of produced water has not been evaluated at Platform Hogan.

Field testing and reservoir modeling would be necessary before the technical feasibility of injection of 100 percent of the produced water can be determined. At the present time, it is uncertain if 100 percent injection of produced water is technologically feasible.

**Environmental factors:** The produced water discharge at Platform Hogan complies with water quality limitations contained in the

NPDES General Permit. This discharge occurs in the open ocean in approximately 155 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from ceasing the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor (MMS 2001a & 2001b). All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100-meter mixing zone.

If overboard discharge of produced water was prohibited, additional power would be required to run the necessary water treatment equipment and injection pumps. Since the power would come from the onshore electricity grid, the associated secondary environmental impacts (additional air emissions) would be at the point of power generation. In addition, the risk of leaks and spills of oil and untreated produced water would increase because of the additional piping, valves, and treatment vessels required for the treatment and separation systems and the injection pumping systems. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved with changing produced water disposal operations from overboard discharge to injection. The volume of produced water to be treated and injected is 891,549 bbls per year, requiring large capacity treatment systems and pumps to handle the volume, as well as to maintain adequate pumping equipment redundancy and performance reliability. The available deck space on the platform is may be inadequate, requiring additional construction. The offshore location also contributes to the overall installation costs because of higher transportation costs and difficult working conditions offshore.

The operator did not provide a screening level cost estimate for the purchase and installation of the major equipment required for injection. Another operator estimate a total capital expenditure of $37 million and operating costs of $700,000 per year for an injection system with a capacity of 5.5 million bbls a year. The costs to inject 20 percent of this volume at Houchin and Hogan could exceed $5 million in capital and $150,000 per year in operating costs. This alternative is not economically feasible for the operator.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact to ocean water quality is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design is regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, power grid impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** Another operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusions*

Injection of 100 percent of the produced water that is currently discharged overboard at Platform Hogan has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platforms Hogan and Houchin.

The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as MMS approval and SBCAPCD permitting) may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES permit expiry date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *9.1.2.b Drilling Muds & Cuttings*

At Platforms Hogan and Houchin, approximately 60 percent of the WBM and cuttings have been discharged overboard with 40 percent being transported to shore for disposal at an operator-owned treatment facility. However, in 2007, the operator predicts that only the WBM and cuttings that do not pass the sheen test will be transported to shore for disposal at an operator-owned treatment facility. The remaining WBM and cuttings volumes will be discharged overboard. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are substantially below the allowable NPDES permit limits of 118,000 bbls and 34,000 bbls, respectively, which can be discharged at Platforms Hogan and Houchin.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection into the production formations and transporting to shore for disposal in a landfill.

##### *9.1.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

When OBM is used for drilling, the drilling muds are separated from the cuttings on a “shale shaker”. The cleaned muds are recycled back to the drilling operation. The cuttings, with some OBM that is not separated, are transported to a slurry unit, where they are ground up, mixed with carrying fluid (typically seawater), viscosifier and inhibitors. The resulting slurry is delivered to a diesel triplex pump, and the cuttings slurry is injected into the annular space between the surface casing and the production casing of an existing permitted well. The cuttings must be ground to pass through a 20 mesh screen prior to pumping downhole.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and well bores.

**Technological factors:** Fracture injection technology is in use on other platforms in the area, but only for lower injection rates. All injection equipment is readily available. However, it is likely the needed equipment installation can not be accomplished without fabrication of additional deck space.

The geologic formations must be suitable for fracture injection. Reservoir characteristics, such as pressure, porosity, and geological structure may limit the injection rates and total capacity. Injecting high volumes of WBM and cuttings could cause significant fracture propagation. This propagation could cause significant damage to geologic formations including the possibility of breaching to the seafloor. Formation evaluations have not been conducted for the large volumes that would require injection, if the overboard discharge of WBM and cutting is prohibited.

Field testing and modeling would be necessary before the technical feasibility of injection of 100 percent of the WBM and cuttings can be determined. Until such studies have been conducted, it is not feasible to consider 100 percent injection of WBM and cuttings.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001).

WBM and cuttings are discharged from platforms in accordance with the NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil, oil-based or synthetic-based fluids, or toxic additives. Toxicity of the WBM is regulated by the NPDES General Permit. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are prevented from being discharged to the ocean.

Secondary environmental impacts will result from the additional power requirements to run the additional injection equipment. The platform power is supplied by the state electricity grid; therefore the secondary environmental impacts would occur at the power generation plant. Also, there may be significant increased air emissions from operation of diesel pumps needed to inject drilling muds and cuttings. No air pollutant emission analyses have been performed to predict the additional emissions because the details of the existing and required generation system and pumping systems are insufficient.

The significant increase in air emissions to inject WBM and cuttings does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. The significant increase in air emissions renders the environmental factor to WBM and cuttings injection as not feasible.

**Economic factors:** Capital costs to add injection pumps for WBM and cuttings would be similar to the costs estimated for reinjecting 100 percent of the produced water. The costs for fabricating additional deck space would be much higher, assuming sufficient space could be built to house injection pumps for both produced water and muds. Insufficient information is available to determine screening level costs. The operator did not provide a screening level cost estimate for the purchase and installation of the major equipment required for injection. Another operator estimate a total capital expenditure of $37 million and operating costs of $700,000 per year for an injection system with a capacity of 5.5 million bbls a year. But even for small volumes of WBM and cuttings, the cost to fabricate additional deck space is considered economically unfeasible for the operator.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to the marine environment is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also, public response to increased air emissions from injection operations and additional power consumption from the state electricity grid is likely to be negative. The increased power consumption may also be objectionable to the public in light of past power shortages.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping required for injection are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platforms Hogan and Houchin has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for WBM and cuttings injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiry date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

##### *9.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. For 2007 through 2009 the operator plans to transport to shore that portion of the WBM and cuttings that does not meet the sheen test.

**Technological factors:** There are no technological limits to the movement of drilling muds to shore. The muds and cuttings will be transported in cuttings boxes, each holding 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. Transportation of WBM and cuttings to shore for disposal is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill or onshore injection well would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 9.1.2.b.i; Environmental factors).

An estimated 18 supply vessel trips would be required to transport 14,400 bbls of WBM and cuttings from Platform Houchin to the Pt. Hueneme. The number of truck trips to transport 14,400bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load, would be approximately 313 truck trips, or approximately 1.2 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply boats and trucks could generate 2.8 tons of NOx per year and 1.5 tons of CO. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 9-2.

**Table 9-2**
**Estimated Emissions at Platforms Hogan and Houchin**

| Emission Constituent | Estimated Incremental Increase of Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) |
|---|---|
| NOx | 8 |
| CO | 3.5 |
| SOx | 0.7 |
| ROG | 1 |
| PM | 0.8 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The increase in air emissions renders the environmental factor to WBM and cuttings transportation to shore as not feasible.

**Economic factors:** Substantial costs would be incurred by the operator to adopt this alternative. The operator estimated costs for onshore treatment of WBM at $40 per bbl, for landfill disposal of WBM at $167 per bbl, and for onshore treatment of water-based drill cuttings at $100 per bbl. The total costs for onshore disposal are estimated to range from $1.5 million to $2.4 million per year. The significant costs for onshore disposal of WBM and cuttings make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to the increases in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity.

**Time factor:** The operator has sufficient supply boat capacity with their existing charter. Therefore lead time is not a controlling factor.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings at Platform Houchin has been assessed for feasibility as an alternative disposal method.

Environmental factors such as increased air emissions due to supply vessel and truck traffic transportation operations make the alternative environmentally infeasible, especially when ocean discharge is localized and considered an insignificant impact to the marine environment.

Transportation of WBM and cuttings to shore is technologically feasible.

The significant costs for onshore disposal of WBM and cuttings make this option uneconomical relative to overboard discharge.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity make this alternative infeasible.

The operator has sufficient supply boat capacity with their existing charter. Therefore lead time is not a controlling factor.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

# 10.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS – PLAINS EXPLORATION AND PRODUCTION (PXP)

## 10.1 PLATFORM IRENE

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Irene. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 10.1.1 Current Practices

#### *10.1.1.a Produced Water*

The average annual volume of produced water generated at Platform Irene was approximately 5.9 million bbls from 2000 to 2006 and is estimated to be 21.3 million bbls from 2007 to 2010. The maximum allowable discharge under the NPDES General Permit is 55.84 million bbls per year. Produced water has been injected for the period between 2000 through 2006 and will continue through 2007. For 2008 through 2010 all produced water is projected to be discharged to the ocean.

The total production stream (oil/produced water emulsion and gas) are shipped via sub-sea pipelines to the Company's Lompoc Oil and Gas Plant located approximately 3 miles north of Lompoc, California. Produced water is separated, treated, and injected into the Lompoc, NW Lompoc, and the Pt. Pedernales (Platform Irene) fields at an average annual cost of $6.3 million for 2000 through 2006. This is equivalent to a per bbl average cost of $0.35, with similar costs forecast through 2010.

**Table 10-1**
**Platform Irene Produced Water Past (2000-2006) and Forecast (2007-2010) Discharges and Costs**

| Volume of Produced Water (bbl x 1,000) | 2000-2006 Min | Max | Annual Average | Total for Period | 2007-2010 Min | Max | Annual Average | Total for Period |
|---|---|---|---|---|---|---|---|---|
| Generated | 4,400 | 8,200 | 5,941 | 41,590 | 20,700 | 21,900 | 21,325 | 85,300 |
| Discharged | 0 | 0 | 0 | 0 | 0 | 21,900 | 21,267* | 63,800 |
| Injected | 4,400 | 8,200 | 5,941 | 41,590 | 0 | 21,500 | 21,500* | 21,500 |
| % injected | 100 | 100 | 100 | 100 | -- | -- | -- | 25.2 |
| Cost ($'000s) | | | | | | | | |
| Discharged | NA | NA | NA | NA | 0 | 6,570 | 6,380* | 19,140 |
| Injected | 1,320 | 2,460 | 1,782 | 12,477 | 0 | 6,450 | 6,450* | 6,450 |
| Total | 1,320 | 2,460 | 1,782 | 12,477 | -- | -- | -- | 25,590 |
| Cost $/bbl | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |

Note: NPDES General Permit maximum annual allowable produced water discharge is 55.8 million bbls per year.
* Average is calculated for those years that volumes were generated.

#### *10.1.1.b Drilling Muds & Cuttings*

The average volumes of WBM, OBM, and associated cuttings are summarized in Table 10-2. No WBM were used from 2000 through 2005 and no OBM were used from 2000 through 2006. An estimated volume of 13,410 bbls of WBM and cuttings were generated in 2006. One-hundred percent of the WBM and cuttings were discharged overboard in 2006.

In 2007, the operator estimates using 28,500 bbls of WBM and 20,000 bbls of OBMs. Over the next three years, WBM usage is expected increase to an average of 49,000 bbls per year, and OBM usage will remain at 20,000 bbls. For 2007 through 2010 all WBM and cuttings are projected to be discharged overboard and OBM all and cuttings are to be injected. The operator provided costs ($10,000 per year) for the analytical testing and reporting that is required by the NPDES General Permit.

**Table 10-2**
**Platform Irene WBM and Cuttings: 2006 and Forecast (2007–2010) Discharge Volumes and Costs**

| Annual average (bbls/year) | 2006 | 2007 | 2008-2010 |
|---|---|---|---|
| WBM Generated | 11,610 | 28,500 | 49,000 |
| WBM Cuttings Generated | 1,800 | 3,000 | 5,733 |
| % of WBM and Cuttings Discharged | 100% | 100% | 100% |
| Discharge Costs ($'000s) | 10 | 10 | 40 |

Notes: NPDES General Permit maximum annual allowable WMB discharge is 105,000 bbls per year.
NPDES General Permit maximum annual allowable WMB cuttings discharge is 30,000 bbls per year.

### 10.1.2 Alternatives to Discharge

#### *10.1.2.a Produced Water*

Produced water from Platform Irene is injected into the onshore Lompoc and NW Lompoc Fields. These onshore fields have a finite remaining life due to onshore production opportunities which will require injection capacity and rising pressure in some areas of the reservoir. Consequently, by the end of 2007 the shortfall in injection capacity will be replaced by overboard discharge. Between 2008 through 2010, and pending the installation of new production treatment process equipment, up to 80,000 bbls per day of produced water may be discharged overboard.

Between 2008 and 2010 the operator predicts an annual average of 21,300,000 bbls per year. The 2008 through 2010 annual discharge volumes for produced water is below the allowable NPDES General Permit limit of 55,845,000 bbls per year that can be discharged from Platform Irene.

Although produced water from Platform Irene is transported to shore for treatment via pipeline, and currently a portion of the flow of produced water is injected in the adjacent Lompoc oil field, no onshore facilities are available with the capacity to accept the total volume of produced water generated.

Only one method has been identified as being a potentially feasible alternative to the overboard discharge of produced water, which is injection back in to the hydrocarbon formation.

**Technological factors:** Approximately 25,000 BWPD is currently being injected at Platform Irene after separation at LOGP and transportation back to the platform via an 8-inch water line. The 8-inch water line has a capacity of approximately 40,000 BWPD. Expanding offshore injection would require an estimated three additional water injection wells and additional water processing and pumping equipment on the platform.

Water injection wells are located structurally low in the formation structure to avoid impacting nearby producing wells. At the current time, there aren't any additional, suitable, structurally low wells available for conversion to injection. Consequently, new wells would have to be drilled. Adequate injection capacity would then hinge on encountering sufficient fractures in the Monterey Formation.

The two existing water injection wells at Platform Irene currently take approximately 6,000 BWPD and 18,000 BWPD, respectively. Using an average injectivity of 12,000 BPWD, three additional wells would be required to replace the 35,000 BWPD planned for overboard discharge.

An evaluation of reservoir capacities, well bore hydraulics and injectivity tests will be required to determine if it is technically feasible to reliably inject the produced water that will be generated at Platform Irene in the future. At the present time, it is uncertain if injection of produced water is technologically feasible.

**Environmental factors:** Injection of produced water has the benefit of removing a discharge from the ocean. However, the environmental benefit may be minor. As required under the general NPDES General Permit, the produced water must meet, after dilution, the more stringent of the Federal Water Quality Criteria or the California Ocean Plan objectives for 26 pollutants found to be present in produced water. The discharge will occur in the open ocean in 242 feet of water, where minimal if any associated environmental impacts are anticipated. Thus any advantage from eliminating the discharge, on the basis of environmental factors, is questionable. The potential impacts of discharging produced water from offshore platforms in deep water have been classified as temporary in duration, local in extent, and minor (MMS 2001a & 2001b). All such discharges are required to meet NPDES General Permit water quality criteria, which were established to protect biological resources outside the 100-meter mixing zone.

If overboard discharge of produced water was prohibited, secondary impacts will increase. Additional power will be required to run the additional treatment system and injection pumps. Since the power would come from the onshore electricity grid, the associated secondary environmental impacts (additional air emissions) would be at the point of power generation. In addition, the risk of leaks and spills of oil and untreated produced water would increase because of the additional piping, valves, and treatment vessels required for the treatment and separation systems and the injection pumping systems. An increase in air emissions renders the environmental factor to produced water injection as not feasible.

**Economic factors:** Significant capital and operating costs are involved for produced water injection. The volume of produced water to be treated and injected is high, requiring large capacity treatment systems and pumps to handle the volume as well as to maintain adequate pumping equipment redundancy and performance reliability

The added water injectors would cost approximately $6,000,000 per well. The operation of additional pumping equipment, which isn't necessary for overboard discharge, would also be required for continuous offshore injection. This would add an additional $1,200,000 annually in power consumption. Annual maintenance of the injection wells would also increase operating expense by approximately $250,000 per well for acid stimulations, routine safety valve testing, and maintenance.

Overboard discharge of produced water is necessary to offset capacity limitations which are developing at the existing onshore disposal sites (Lompoc & NW Lompoc Fields). Replacement of the lost capacity via an expansion of the existing injection program, while technically feasible, is cost prohibitive due to the cost for the new injection wells ($18 million) and added annual operating expense ($1.95 million). The added expenses would result in a reduced economic life for the platform and a loss in recoverable reserves. The significant capital and operating costs for produced water injection make this option uneconomical relative to the overboard discharge.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection operations is likely to be negative.

Offshore injection and facility design is regulated by MMS. The regulatory framework is complex and deals with many issues including the impacts on production and the economic life of the oilfield, etc. These factors are complexly tied to reservoir engineering and oil field production engineering principals not within the scope of this document. Whether MMS would approve site specific injection and facility design plans is unknown.

The mixed positive and negative perceived environmental impacts, and regulatory approval considerations renders the social factor to produced water injection as uncertain.

**Time factor:** The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, and testing. The 24 to 48 months needed to convert to produced water injection is considered feasible.

*Conclusion*

Injection of 100 percent of the produced water at Platform Irene has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location and an increased potential for spills make the alternative infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Technical feasibility is uncertain. Technically, injection of all produced water is possible at some platforms; however, additional reservoir testing would be required to determine the feasibility of 100 percent injection at Platform Irene.

The significant capital and operating costs for produced water injection make this option uneconomical relative to the current practice of overboard discharge.

Social factors are uncertain. Public perception might favor injection over discharge. Regulatory issues (such as MMS approval and SBCAPCD permitting), based on the potential impacts of injection activities, may result in this alternative being infeasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the produced water is considered not feasible, based on the definition provided in the California Coastal Management Plan.

#### *10.1.2.b Drilling Muds & Cuttings*

At Platform Irene, WBM and cuttings generated in 2006 were discharged overboard. For 2007 through 2010, the WBM and cuttings forecast for discharge range in volume from 31,500 to 58,900 bbls. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 105,000 and 30,000 bbls, respectively, for Platform Irene.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings; injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill.

##### *10.1.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

WBM is used in the shallower, larger diameter (i.e., larger volume) well intervals where drilling is simpler and faster. There is more hole enlargement and more attrition and dispersion of cuttings in these intervals, which necessitates more dilution and generates higher volumes/rates of WBM and cuttings. For example, drilling with WBM about 20 percent of the drilling time generates greater than 80 percent of drilling fluid and cuttings. Injecting WBM and cuttings would consume much more of the limited fraction injection capacity that is available. It would also require dramatic increases in load bearing deck space, the volume and rate capacity of injection equipment and slurry holding capacity than is currently required for injection of OBM and cuttings. Even if pump capacity is increased, there are physical limitations on the rate that fractures will accept drilling mud and cuttings. In the case of WBM and cuttings, these rates could impede drilling rates and thus drilling efficiency/cost. WBM is typically used in shallow well intervals with higher sand content where there can be high drilling rates and therefore high volume generation rates. The higher concentration of sand is very abrasive to surface and downhole equipment. It increases the potential for mechanical failures of equipment, casing, and well bores.

**Technological factors:** The technology is in use on other platforms in the area. All equipment is available. However, the needed equipment installation can not be accomplished without extensive fabrication of additional deck space. Pump capacity would need to be increased from about 23,500 bbls a year (2007 projected OBM and cuttings volume) to 82,400 bbls a year (2008 projected OBM, WBM, and associated cuttings volume). An engineering study of the electrical load distribution system would also be required to determine additional equipment needs to supply the power to the new pumps.

The geology of the production formations must be suitable for injection. Reservoir characteristics, such as pressures, porosity, and geological structure may limit the injection rates and total capacity. Thus several dedicated injection wells are needed for redundancy to allow continuous drilling operations in case an injection well is clogged. To un-clog an injection well requires a specialized coil tubing unit (CTU) to perform the clean out operation. This equipment is may not be readily available when needed causing the drilling operation to be suspended. This was experienced many times during the Rocky point drilling campaign from platform Hidalgo. Additionally, injection well treating fluids and equipment such as acid and associated acid pumping equipment may not be readily available when needed causing suspension of the drilling operation. Both of these scenarios are highly likely and will result in added expense to the operator as well as a delay in oil production. Injection of WBM and cuttings has not been evaluated at Platform Irene and the injectivity of large volumes of WBM and cuttings slurry may not be possible. Until such studies have been conducted, it is not feasible to consider injection of WBM and cuttings.

**Environmental factors:** Injection or transport to shore of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of ceasing the discharge may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Although ocean discharge of WBM and cuttings have been shown to affect benthic organisms through physical changes to sediment grain size and by temporary burial or smothering, the effects are limited to within a few hundred feet from the discharge (Battelle, 2005; MMS, 2003, 1995a, 1995b; E&P Forum & UNEP, 2001.

WBM and cuttings are discharged from platforms in accordance with the General NPDES General Permit requirements. The permit limits the volumes discharged and prohibits the discharge of drilling muds containing free oil or oil-based or synthetic-based fluids or toxic additives. In addition, drilling mud bioassays are required to be conducted for each mud system. The major components of WBM are clay and bentonite, which are chemically inert and nontoxic. The toxicological effects of heavy metals associated with WBM, (cadmium, lead, zinc, and especially barium) have been shown to be minor because the metals are bound in mineral form and hence have limited bioavailability (Hyland et al., 1994). Because of the strict toxicological requirements that must be satisfied, significant impacts to the benthic species are not expected to occur (County of Santa Barbara, 2006 & 2002) as a result of ocean discharge of WBM and cuttings.

The coarse-grained drilling cuttings accumulate under and in the immediate vicinity of the platform jacket. The benthic environment at the foot of the platform jacket is changed significantly as a result of the presence of the platform legs and the build-up of biological detritus from shellfish and corals and other marine organisms falling from the platform legs. Ceasing the discharge of WBM and cuttings will have only a minor impact to the benthic communities surrounding the platform. The initial adverse impact is limited in area to a few hundred feet from the platform and the accumulation of shell hash from the platform legs will prevent the original benthic communities from being re-established for many years regardless of whether WBM and cuttings are being discharge to the ocean.

Secondary environmental impacts may result from the additional power requirements to run the increased number of pumps. The platform power is supplied by the state electricity grid, therefore the air emissions resulting for the use of more and larger pumps would occur at the power generation plant and is likely to be negligible, relative to the power plant emissions. No air pollutant emission analyses have been performed to predict the additional emissions because the details of the existing and required generation system and pumping systems are insufficient. However, it is likely that the additional emissions will be generated and render WBM and cuttings injection as environmentally infeasible.

**Economic factors:** Capital costs to increase the volume capacity of WBM and cuttings injection is estimated by the operator to be $1,000,000.

Additionally, the lower cost option of converting a producing well to injection may not be feasible. The conversion well must be strategically positioned to the targeted injection formation. Thus, it is highly likely that new dedicated injection wells will be needed. The estimated cost to drill several cuttings re-injection wells to the targeted injection formation can exceed $12,000,000. In addition, the estimated costs for acidizing and maintenance of each injection well is $425,000 per year. There is a risk that any new cuttings injection well will not readily accept cuttings and drilling fluid at an injection pressure below fracture gradient as required by MMS regulations. The costs for fabricating additional deck space would be much higher, assuming sufficient space could be built. The significant capital and operating costs for injection make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to total injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced. The fact that all construction is on the platform and out of the view of the public is also likely to be considered a positive attribute. However, there may be public objections to the increased activity associated with the construction phase (platform activities, increased supply vessel and truck traffic, increased air emissions in support of construction activities). Also public response to increased air emissions from injection is likely to be negative.

Offshore injection and facility design are regulated by MMS. Whether MMS would approve site specific injection and facility design plans is unknown.

The primarily negative environmental impacts (increased air emissions) and regulatory approval considerations (such as MMS approval and SBCAPCD permitting) renders the social factor to WBM and cuttings injection as infeasible.

**Time factor:** The additional equipment, injection pumps, slurry tanks, and miscellaneous piping are readily available. The operator estimates that approximately 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered feasible.

*Conclusions*

Injection of 100 percent of the WBM and cuttings that are currently discharged overboard at Platform Irene has been assessed for feasibility as an alternative disposal method.

Environmental factors of increased air emissions at the platform during construction and equipment installation, increased power demand, resulting in increased emissions at a remote location, and increased air emissions due to injection operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment.

Uncertainty around the ability of the platform to physically support additional deck space in addition to uncertainty over the ability of the substrate to accept high volumes of WBM and cuttings reliably leave the technical feasibility in doubt.

The significant capital and operating costs for WBM and cuttings injection make this option infeasible relative to the current practice of overboard discharge.

Social factors are mixed. However, the primarily negative environmental impacts (increased air emissions), the power grid impacts, and regulatory approval considerations (such as permitting from MMS and the SBCAPCD) render the social factor to WBM and cuttings injection as not feasible.

The time required to accomplish the operational changes from overboard discharge to injection is estimated to be from 2 to 4 years. While not making the alternative infeasible, the period will extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the definition provided in the California Coastal Management Plan.

*10.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. These volumes are generally only transported due to the following limited circumstances: (1) for OBM recycling (because it is economical to recycle OBM but not WBM), (2) because the cuttings fail the sheen test and therefore are not authorized for discharge and the particle size cannot be ground fine enough for injection, or (3) because injection capacity is full. At Platform Irene all OBM and cuttings are proposed for injected and all WBM and cuttings are to be discharged to the ocean. The projected total volume of WBM and associated cuttings requiring disposal in 2007 is 31,500 bbls. From 2008 to 2010 the predicted total volume of WBM and cuttings requiring disposal is on average 54,700 bbls, which is also expected to be discharged overboard.

**Technological factors: Technological factors:** There are no technological limits to the transportation of drilling muds to shore. Muds and cuttings are usually transported in cuttings boxes, each holding 23 bbls of mud. One supply vessel can carry 35 boxes, equivalent to 805 bbls per trip. Transport from the unloading port to a suitable landfill facility in California can be accomplished using trucks. Transportation of WBM and cuttings to shore is technologically feasible.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 10.1.2.b.i; Environmental factors).

In addition, the secondary impacts from air emissions would be significant. The primary regulated pollutants of concern in Santa Barbara County are nitrous oxides (NOx) and reactive organic gases (ROG). Both NOx and ROG are considered precursors to ozone formation, for which Santa Barbara County is presently in non-attainment.

Emissions will be created from the supply vessels, from the trucks required to transport the muds and cuttings to the landfill, and from the equipment used to load and unload the supply vessels and trucks. An estimated 68 supply vessel trips would be required to transport 54,700 bbls of WBM and cuttings from Platform Irene to Pt. Hueneme. The number of truck trips required to transport 54,700 bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load would be 1,189 truck trips, or approximately 5 trucks per day for one year (based on a 5-day per week delivery schedule).

Most of the increased air emissions would come from the supply vessels needed to transport the WBM and cuttings to shore. The estimated air emissions from the supply vessels and trucks could generate more than 31 tons of NOx and more than 12 tons of carbon monoxide (CO) per year. Additional emissions would occur during loading and unloading operations from the supply vessels and trucks. Total increased ROG and sulfur oxides (SOx) emissions would be approximately 3.2 tons per year for each. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 3rd quarter 2005 through 2nd quarter 2006) and the total permitted platform emissions is presented Table 10-3.

**Table 10-3**
**Comparison of Estimated and Permitted Emissions at Platform Hidalgo**

| Emission Constituent | Total Annual Emissions (3rd Qtr 2005 to 2nd Qtr 2006; tons/year) | Estimated Incremental Increase to Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 11.47 | 37 | 322.6% | 45.67 |
| CO | 3.64 | 14.1 | 387.4% | 19.83 |
| SOx | 1.3 | 3.2 | 246.2% | 9.31 |
| ROG | 22.29 | 3.2 | 14.4% | 28.77 |
| PM | 1.35 | 3.9 | 288.9% | 5.52 |

Another potentially significant secondary impact is the consumption of limited onshore disposal facility capacity for WBM and cuttings when overboard discharge has minimal offshore environmental impact.

The significant increase in air emissions to transport WBM and cuttings to shore for disposal does not appear environmentally sound given the minimal seafloor impact resulting from the discharge of WBM and cuttings. Permitting for the additional air emissions may not be possible within the SBCAPCD because there are no emission reduction credits available to offset the anticipated injection pump and transport vessel emissions. The significant increase in air emissions renders the environmental factor to the transportation of WBM and cuttings to shore for disposal as not feasible.

**Economic factors:** A typical supply boat charter is about $16,000 per day. The cost for 68 roundtrips of 24 hours each is approximately $1.08 million. Typical landfill disposal charges are $10-$20 per bbls with transportation costs of $2-$4 per bbls. Landfill disposal costs for 54,700 bbls could range from $0.65 million to $1.31 million. The total costs for onshore disposal could range from $1.73 million to $2.39 million, which is substantially greater than the costs of overboard discharge. Transport to shore could increase operating costs by 173 to 239 times making this disposal alternative economically infeasible to the operator.

**Social factors:** Public response to the increases in vessel traffic required to ship large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative when the environmental benefit to the marine environment is weighed against the secondary impacts of significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity.

**Time factor:** Supply vessels are not readily available in southern California. The operator has long-term contracts with vessel owners to provide one supply boat for the platform. The supply boat is shared with eight other platforms. The amount of time to procure new supply vessels and to obtain operating permits, assuming air permits would be issued, is uncertain, but estimated to be not less than one year.

*Conclusions*

Transportation to shore for disposal of the WBM and cuttings that is currently discharged overboard at Platform Irene has been assessed for feasibility as an alternative disposal method.

Environmental factors of significant increased air emissions due to supply vessel and truck transportation operations make the alternative environmentally infeasible, especially when the current discharge is localized and considered an insignificant impact to the marine environment. In addition, Santa Barbara County is presently in non-attainment for ozone, which is formed from NOx and ROG, and no emission reduction credits are available within the Santa Barbara County to offset the additional emissions associated with the increase in the number of vessel trips to transport the mud and cuttings to shore.

Transportation of WBM and cuttings to shore is technologically feasible.

Economic factors of an increase by 173 to 239 times the estimated costs of overboard discharge make this alternative economically infeasible to the operator.

Social factors relating to public opinion of shipping large volumes of drilling muds and cuttings to shore for disposal in approved landfills may be negative. When the environmental benefit to the marine environment is weighed against the secondary impacts (significant additional air emissions, supply vessel traffic, increased truck traffic, and consumption of licensed disposal site capacity) and regulatory approval considerations (such as SBCAPCD permitting) this alternative is considered infeasible.

The time required to procure additional supply boats and permit them is uncertain, making the feasibility of this factor uncertain. While not making the alternative infeasible, the period may extend beyond the current NPDES General Permit expiration date.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the definition provided in the California Coastal Management Plan.

# 11.0 DISCHARGE ALTERNATIVES FEASIBILITY ANALYSIS – VENOCO INC.

## 11.1 PLATFORM GAIL

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Gail. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM (and OBM if used) and associated cuttings are described.

### 11.1.1 Current practices

#### *11.1.1.a Produced Water*

No produced water data was supplied for Platform Gail for 2000 and 2001. The average annual volume of produced water generated at Platform Gail from 2002 to 2006 was 7.03 million bbls per year (approximately 808,400 gallons per day), totaling 35.1 million bbls over the five year period. Of this total, 94 percent was injected into formation and the remaining 6 percent (2.1 million bbls) was discharged overboard. An estimated total of 65.7 million bbl (16.4 million bbls per year) of produced water is forecast to be generated for 2007 through 2010. This is more than double the recent rate of production which is due to a new seawater injection program. The operator plans to inject most of the volume generated during this period. During periods of injection equipment maintenance, produced water discharges to the ocean will continue to occur.

Total fluid production (an oil/produced water emulsion) from Platform Gail is treated on-platform prior to discharge or injection. The costs for the treatment and discharge of produced water from Platform Gail have been estimated to be $0.15 per bbl for 2002 through 2005. Similarly, produced water treatment and discharge costs are forecast at $0.15 per bbl for 2007 through 2010.

#### *11.1.1.b Drilling muds and cuttings*

WBM and cuttings were generated in 2002, 2005, and 2006. OBM and cuttings were not generated from 2002 through 2006. Average, annual, and projected volumes of WBM and cuttings and OBM and cuttings are summarized in Table 11-1. During

2000, 2001, 2003, and 2004, no WBM and cuttings were generated. During 2002, 2005, and 2006, the total volume of all muds and cuttings generated was estimated at 27,099 bbls, with WBM making up approximately 78 percent of the total.

In 2002, 100 percent of the WBM and cuttings were discharged overboard at the platform. In 2005, 60 percent of the WBM and 28 percent of the water-based cuttings were discharged overboard at the platform. The remaining 40 percent of the WBM and 72 percent of the water-based cuttings were transported to shore for disposal at a landfill or for onshore injection because they were not suitable for ocean discharge. In 2006, 100 percent of the WBM and cuttings were transported to shore for disposal at a landfill or onshore injection.

Between 2007 and 2010, the operator is planning to increase the WBM usage to an average of 8,770 bbls per year. OBM are not planned to be used at Platform Gail. Sixty percent of the all WBM and 27 percent of the associated cuttings is projected to be discharged to the ocean in 2007 through 2010. The remaining WBM and cuttings volumes will be transported to shore for disposal at a landfill or onshore injection because this proportion is expected to contain some oily materials and will not pass the oil sheen test. Onshore disposal costs have been estimated by the operator at $30 per bbl.

Drilling activities are proposed to recommence at Platform Grace in 2007. Some drilling wastes are planned to be transported on crew boats or supply vessels to Platform Gail for injection, to shore for disposal, or for discharge at Platform Grace.

**Table 11-1**
**Drilling Muds & Cuttings Volumes Generated at Platform Gail**

| Annual average (bbl/year) | 2002 | 2005 | 2006 | Average* | 2007-2010 |
|---|---|---|---|---|---|
| Water Based Mud | 8,021 | 8,770 | 4,360 | 7,050 | 8,770 |
| WBM Cuttings | 2,037 | 3,347 | 564 | 1,983 | 3,350 |
| **Total Annual Average** | **10,058** | **12,117** | **4,924** | **9,033** | **12,120** |

*Average volumes for years when drilling occurred

### 11.1.2 Alternatives to Discharge

#### *11.1.2.a Produced Water*

Approximately 16.425 million bbls of produced water is projected to be generated at Platform Gail annually from 2007 through 2010. All future produced water is anticipated to be injected offshore after being treated on-platform. During periods of injection equipment maintenance, produced water discharges to the ocean will continue to occur, although the allowable NPDES General Permit limit is 4,380,000 bbls per year that can be discharged at Platform Gail.

**Technological factors**: Injection technology is currently in use on Platform Gail. The geology of the production formations is proven to be suitable for injection. The operator considers 100 percent injection of produced water to be a feasible alternative to overboard discharge. A failure or breakdown of the injection system may result in the discharge of produced water overboard, however. Injection cannot be guaranteed to be 100 percent reliable.

**Environmental factors:** To run the necessary water treatment equipment and injection pumps, additional power would be required to accommodate the increased amount of produced water treated in the system. The platform power is supplied by onboard generators using produced natural gas, resulting in increased air emissions compared to overboard discharge.

Although there will be an increase in air emissions, the operator is planning to inject 100 percent of the produced water.

**Economic factors:** No additional permitting, engineering design, equipment and material procurement, or construction is anticipated to be required for 100 percent injection. Increased operating costs will be small because already 94 percent of the produced water has been injected.

**Social factors:** Public response to total injection of produced water is likely to be positive because a perceived environmental impact to ocean water quality is being reduced.

**Time factor:** No additional time would be required for permitting, engineering design, equipment and material procurement, construction, and testing because injection equipment is currently in place and in use on Platform Gail.

*Conclusion*

Beginning in 2007 at Platform Gail, 100 percent of the produced water is proposed for injection. The operator considers produced water injection to be a feasible alternative to overboard discharge. However, produced water injection cannot be considered to be 100 percent reliable and overboard discharge is a necessary option to maintain in the case of unexpected system failures and during scheduled preventative maintenance of the injection system.

#### *11.1.2.b Drilling Muds & Cuttings*

From 2007 to 2010, the operator estimates an 80 percent increase in the volume of WBM and cuttings generated per year. Of this amount, 60 percent of WBM will be discharged overboard and 40 percent will be transported to shore for disposal at a landfill or onshore injection. Additionally, 28 percent of water-based cuttings will be discharged overboard and 72 percent will be transported to shore for disposal at a landfill or onshore injection. The 2007 through 2010 projected annual discharge volumes for WBM, (8,770 bbls) and cuttings, (3,350 bbls) are below the NPDES General Permit limits of 49,500 bbls and 28,700 bbls, respectively, at Platform Gail. Overall, about 50 percent of the total WBM and cuttings is planned to be discharged overboard, 20 percent is to be injected onshore, and 30 percent for disposal at an onshore landfill. All of these figures are based on historical practices for the handling of WBM and cuttings and may vary significantly from year to year for 2007 through 2010.

Two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings: injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill. The operator is planning to use a combination of both methods to reduce the volume of muds and cuttings discharged overboard. As required by the NPDES General Permit, only clean mud and cuttings will be discharged. Any WBM or cuttings that fail the oil sheen test will be injected if the cuttings are suitable for grinding to the required particle size. If the cuttings can not be easily treated for injection, or if the cuttings generation rate is greater than the receiving capacity of the injection well, the cuttings will be transported to shore for disposal.

##### *11.1.2.b.i Injection of WBM and Cuttings*

Injection of drilling fluids and cuttings is fundamentally different than produced water injection in that drilling mud and cuttings injection involves fracturing of geologic strata while produced water is injected into pore spaces. Considerations associated with drilling mud and cuttings injection are the number, direction, height, and capacity of fractures created and limiting the fractures to a set zone so that there is ample boundary area around the fractures. The latter concern is the reason that fracture injection of solids laden drilling waste is not normally employed in or near producing strata due to concerns about damage to the production formations.

**Technological factors:** Fracture injection technology is planned to be used on Platform Gail but the formation capacity is limited and cannot accept all the estimated volumes of produced water, WBM, and water-based cuttings at the rate they are generated.

The cuttings, with some adhering WBM, are transferred to a slurry unit, where they are ground up, mixed with carrying fluid (the produced water), viscosifiers, and inhibitors. The resulting cuttings slurry is injected into the annular space between the surface casing and the production casing of an existing permitted well. The cuttings must be ground to pass through a 20 mesh screen prior to downhole injection. The availability of produced water needed to slurry the cuttings and the injection pump capacity may limit the volume of cuttings that can be injected.

The geologic formations are suitable for fracture injection. However, injecting the high volumes of WBM and cuttings could cause fracture propagation. This propagation could cause damage to geologic formations, including the possibility of breaching to the seafloor. Formation evaluations have been conducted and the maximum possible volume of cuttings will be injected along with all the produced water without compromising the production capacity of the remaining hydrocarbon formations. The operator has determined that, while injection of drilling wastes are planned for future operations, injection of 100 percent of the WBM and cuttings is not technologically feasible because of the limited receiving capacity of the production formations and the characteristics of some cuttings prevent adequate treatment to avoid clogging of the injection wells.

**Environmental factors:** Injection of all drilling muds and cuttings has the benefit of removing a discharge from the marine environment. However, the environmental benefit of diverting small volume, intermittent discharges may be minor because the potential environmental impacts from the discharge of WBM and cuttings are considered to be localized and non-significant (County of Santa Barbara, 2006 & 2002, E&P Forum & UNEP, 2001; Phillips et al., 1998; MMS, 1995a & 1995b; Steinhauser et al., 1994).

Secondary and minor environmental impacts will result from the additional power requirements to run the injection equipment. The platform power is supplied by onboard generators using produced natural gas. A small increase in air emissions will result from the injection pumps. An estimate of the increased annual emissions due to WBM and cuttings injection compared to the total annual emissions has not been conducted.

The increase in air emissions to inject all WBM and cuttings is estimated to be minor and not likely to make injection of WBM and cuttings infeasible because of environmental factors.

**Economic factors:** Significant capital and operating costs are involved with changing from WBM and cuttings discharge to injection. At Platform Gail, injection of partial volumes of WBM and cuttings will be anticipated in addition to full injection of produced water, starting in 2007. However, total injection of WBM and cuttings is not economically feasible for the operator because of the significant costs associated with expansion of deck space on Platform Gail The operator did not provide a screening level cost estimate to increase the deck space or for the purchase and installation of the equipment necessary for an injection system. The capital and operating costs are anticipated to be significant (in excess of $2 million) and make this option uneconomical relative to the current practice of overboard discharge.

**Social factors:** Public response to injection of WBM and cuttings is likely to be positive because a perceived environmental impact to ocean is being reduced. Public response to increased air emissions from injection operations is likely to be positive because the anticipated additional emissions are minor and will occur offshore. No identified social factors make the injection of WBM and cuttings alternative infeasible.

**Time factor:** There is the potential that additional injection equipment, injection pumps, slurry tanks, and miscellaneous piping will be required. Additional deck space will also be necessary. An estimated 24 to 48 months would be required for permitting, engineering design, equipment and material procurement, construction, installation, and testing. The 24 to 48 months needed to convert to WBM and cuttings injection is considered infeasible.

*Conclusions*

The operator is planning to inject about 80 percent of the annual volume of water-based cuttings generated from 2007 through 2010, but no WBM are proposed for injection. Injection of 100 percent of

WBM and cuttings that will be discharged overboard at Platform Gail has been assessed for feasibility as an alternative disposal method.

Injection of 100 percent of the WBM and cuttings is not technologically feasible. The operator has determined that, while injection of drilling wastes are planned for future operations, the limited receiving capacity of the production formations and the potential clogging of the injection wells with cuttings, reducing reliability, prevents all WBM and cuttings from being injected.

Environmental factors of increased power demand and increased air emissions required to achieve 100 percent injection are estimated to be minor and do not significantly impact the environmental feasibility of this alternative.

Economic factors make the alternative of 100 percent injection of WBM and cuttings infeasible, because of the significant capital costs associated with expanding the platform deck space. Operating costs also would be greater than under currently planned operations.

No identified social factors make the injection alternative infeasible.

The time factor of 24-48 months to construct additional deck space does make this alternative infeasible.

Overall, the alternative of injecting 100 percent of WBM and cuttings is considered not feasible, based on the operational and technical constraints associated with the required rate of injection into the hydrocarbon formations and the substantial economic costs and time required to expand the platform deck space.

#### *11.1.2.b.ii Transportation of WBM and Cuttings to Shore for Disposal*

Relatively small volumes of drilling muds and cuttings are routinely transported from platform to shore for treatment, recycling, or disposal. The predicted WBM and cuttings volumes to be discharged in 2007 are estimated at 6,231 bbls, assuming 40 percent of WBM and 72 percent of water-based cuttings are transported to shore for disposal or onshore injection. If this amount was to be transported to shore for disposal instead of being discharged overboard, it would be a 26 percent increase in the volume transported to shore in 2006.

**Technological factors:** There are no technological limits to the movement of drilling muds and cuttings to shore. However, the alternative of transporting 100 percent of WBM and cuttings to shore would require additional storage space on deck or additional supply boat trips at the time the muds and cuttings are generated. A deck extension would be necessary to provide space for the increased number of cuttings boxes required for the storage and transport of mud and cuttings. A structural study would be required to determine if the platform can safely support such a deck extension.

The muds and cuttings are usually transported in cuttings boxes, each holding approximately 23 bbls of mud. One supply boat can carry 35 boxes, equivalent to 805 bbls per trip. Approximately eight additional supply boat trips per year would be necessary to transport all WBM and cuttings to shore.

It is not certain if transportation of 100 percent of WBM and cuttings to shore is technologically feasible because of the lack of space to store the drilling wastes on the platform until they can be offloaded to a supply boat for transport to shore.

**Environmental factors:** Disposing of WBM and cuttings at an onshore landfill would decrease discharges of the mud and cuttings to the marine environment. However, the environmental benefit may be minor (see report section 11.1.2.b.i; Environmental factors).

Incremental secondary impacts from air emissions will occur, however they may not be significant because of the small additional volume of cuttings to be transported (a total of 13,400 bbls for 2007 through 2010). Additional emissions will be created from the supply vessels and trucks required to transport the muds and cuttings to the landfill and from the equipment used to load and unload the supply vessels and trucks. An estimated 8 supply vessel trips would be required to transport the annual anticipated volume of 6,231 bbls of WBM and cuttings that are planned to be discharged from Platform Gail to Pt. Hueneme. The number of truck trips to transport 6,231 bbls of mud and cuttings from Pt. Hueneme to disposal sites in Kern County, based on 2 boxes (46 bbls) per load, would be 135 truck trips, or approximately 2.5 trucks per week over the period of one year.

The estimated air emissions from the additional supply boats and trucks trips could generate 1 ton of $NO_x$ and 0.6 tons of CO per year. Additional small emissions would occur from unloading operations from the supply vessels and trucks. Total increased $SO_x$ emissions would be approximately 0.2 tons per year. A comparison of the estimated increased annual emissions of WBM and cuttings transportation for onshore disposal to the total annual emissions (for 2005) and the total permitted platform emissions is presented in Table 11-2.

It is possible that the ROG limit may be exceeded based on the estimated emissions calculation. More detailed estimates of cuttings volumes and air emission calculations will be necessary to provide a more accurate estimate. This disposal alternative must be classified as being of uncertain feasibility, based on secondary environmental impacts.

**Table 11-2**
**Comparison of Estimated and Permitted Emissions at Platform Gail**

| Emission Constituent | Total Annual Emissions for 2005 (tons/year) | Estimated Incremental Increase to Annual Emissions Due To WBM & Cuttings Transportation to Shore for Disposal (tons/year) | Estimated Percent Increase in Annual Emissions | Total Permitted Facility Emissions (tons/year) |
|---|---|---|---|---|
| NOx | 82.10 | 2.7 | 3.3% | 85.07 |
| CO | 96.86 | 1.3 | 1.3% | 105.64 |
| SOx | 1.86 | 0.2 | 10.7% | 2.63 |
| ROG | 33.47 | 0.3 | 0. 9% | 33.65 |
| PM | 5.16 | 0.3 | 5.8% | 5.34 |

**Economic factors:** Substantial costs would be incurred by the operator to adopt this alternative. The operator did not provide a screening level cost estimate to increase the deck space. The capital costs are anticipated to be significant (other operators have estimated a cost of greater than $2 million). The operator estimated costs to transport all mud and cuttings to shore for disposal are $350,000 per year for 12,120 bbls, equivalent to about $30 per bbl. The combination of capital and operating costs make this option uneconomical to the operator, relative to the current practice of overboard discharge.

**Social factors:** Because a substantial portion of the muds and cuttings generated are already transported to shore, it is unlikely that public response to the increase in supply vessel and truck traffic will be negative.

**Time factor:** To transport 100 percent of the WBM and cuttings to shore will required additional supply vessel trips and additional deck space on the platform to store the mud and cuttings before being transported to shore. Construction of additional deck space is estimated to require 24 to 48 months to complete, making the option infeasible to the operator.

*Conclusions*

It is not certain if transportation to shore of 100 percent of WBM and cuttings generated at Platform Gail is technologically feasible because of the lack of space to store the drilling wastes on the platform until they can be offloaded to a supply boat for transport to shore.

Secondary environmental impacts from additional air emissions from the additional supply vessel and truck trips required would be created, but they are probably not sufficient to make the alternative infeasible.

Additional costs are associated with transporting all muds and cuttings to shore. Capital costs for the construction of additional deck space are substantial and sufficient to make the alternative economically infeasible to the operator.

Social factors are unlikely to affect the feasibility of onshore disposal because a substantial portion of the muds and cuttings are already being transported to shore.

Time is a factor that will affect the feasibility because, although all equipment required for transportation is in place and the number of additional supply boat trips is small, construction of additional deck space is estimated at 2 to 4 years to complete, making the option infeasible to the operator.

Overall, the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible, based on the technological and economic factors.

## 11.2 PLATFORM GRACE

This section provides an analysis of the feasibility of alternatives to current discharge activities at Platform Grace. Alternatives are analyzed using the criteria listed in the definition of feasibility provided in the California Coastal Management Plan. The current practices for the disposal of produced water and WBM and OBM and associated cuttings are described.

### 11.2.1 Current practices

Platform Grace has been idle for over 10 years. However, Venoco plans to drill and restore production operations at Platform Grace in 2007.

#### *11.2.1.a Produced Water*

Platform Grace did not generate produced water from 2000 to 2006. When operations are restarted at Platform Grace in 2007, an average annual volume of 5,000 bbls per year (equivalent to approximately 575 gallons per day) of produced water is anticipated through 2010.

Produced water generated at Grace will be shipped via sub-sea pipeline for injection at Platform Gail. The costs for treatment and discharge of the produced water from Platform Grace have been estimated to be $0.20 per bbl for 2007 through 2010.

#### *11.2.1.b Drilling muds and cuttings*

The annual average volumes of WBM and cuttings are summarized in Table 11-3. Between 2000 and 2006, no WBM, OBM, or cuttings were generated at Platform Grace. The 2007 through 2010 projected annual discharge volumes for WBM and cuttings are below the allowable NPDES General Permit limits of 49,500 and 28,700 bbls, respectively, which can be discharged at Platform Grace.

**Table 11-3**
**Drilling Muds & Cuttings Volumes Generated at Platform Grace**

| Annual average (bbl/year) | 2000-2006 | 2007-2010 |
|---|---|---|
| WBM | 0 | 8,770 |
| WBM Cuttings | 0 | 3,350 |
| OBM | 0 | 8,770* |
| OBM Cuttings | 0 | 3,350* |
| **Total** | **0** | **24,240*** |

Note: * Not to exceed WBM volumes

During 2007-2010, the operator estimates generating 8,770 bbls of WBM and 3,350 bbls of water-based cuttings each year at Platform Grace. The anticipated volumes of OBM and cuttings to be required are not known, but it will not exceed the volumes of WBM and cuttings used. Some drilling wastes are planned to be transported on crew boats or supply vessels to Platform Gail for injection, to shore for disposal or for discharge at Platform Grace.

The WBM and cuttings volumes are similar to the volumes predicted to be generated at Platform Gail. Approximately 60 percent of the WBM (5,300 bbls) and 28 percent of the associated cuttings (940 bbls) are projected to be discharged to the ocean annually during 2007 through 2010. It is assumed that the remaining volumes of WBM and cuttings will not pass the sheen test and will be transported to shore for disposal at a landfill or for onshore injection.

### 11.2.2 Alternatives to Discharge

#### *11.2.2.a Produced Water*

One-hundred percent of produced water from Platform Grace is planned to be injected at Platform Gail beginning in 2007. Presented in report section 11.1.2.a is a discussion of the alterative method to produced water discharge at Platform Gail. As concluded in report section 11.1.2.a, it will be necessary to maintain the option of discharging produced water overboard in the case of unexpected process upset, unexpected failures or clogging of the injection system, and during preventative maintenance of the pumping system.

#### *11.2.2.b Drilling Muds & Cuttings*

Muds and cuttings planned to be used at Platform Grace will be transported by vessel to Platform Gail for injection, to shore for disposal (OBM and cuttings), or for discharge at Platform Grace. The estimated volumes of WBM and cuttings projected to be generated at Platform Grace are equal to the projected volumes to be generated at Platform Gail. Presented in report section 11.1.2.b, two methods have been identified as being potentially feasible alternatives to the overboard discharge of WBM and cuttings at Platform Gail: injection by fracture into technically acceptable formations or transporting to shore for disposal in a landfill. Report section 11.1.2.b.i concluded that the alternative of injecting 100 percent of the WBM and cuttings is considered not feasible, based on the operational and technical constraints associated with the required rate of injection into the hydrocarbon formations and the substantial economic costs and time required to expand the platform deck space. In addition, report section 11.1.2.b.ii concluded that the alternative of transporting 100 percent of the WBM and cuttings to shore for disposal is considered not feasible based on the technological and economic factors.

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# APPENDIX A
## QUESTIONNAIRE SENT TO EACH OPERATOR TO GATHER PRELIMINARY PLATFORM-SPECIFIC DATA

**Table 1.**
**Platform-specific information**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Platform-specific Data requests** | |
| 9 | For year 2006 please attach the quarterly Discharge Monitoring Report (DMR) forms (EPA Form 3320-1) submitted in compliance with the NPDES General Permit CAG280000. |
| 10 | For years 2005 and 2006 please attach the laboratory analytical reports submitted in compliance with the NPDES General Permit CAG280000. |
| 11 | Please attach the Material Safety Data Sheets (MSDS) for drilling fluids (muds) and drilling additives utilized in 2005 and 2006 |
| 12 | Injury rate (OSHA recordable, 2000-2006) |
| 13 | - for cuttings/drilling muds-related activities |
| 14 | - for produced water treatment/disposal activities |
| 15 | Were any of the above the result of crossloading or disposal of cuttings or produced water? |
| 16 | Spills (reportable quantity, 2000-2006) |
| 17 | - volume |
| 18 | - number |
| 19 | Were any of the above the result of crossloading or disposal of cuttings or produced water? |
| 20 | Existing storage capacity on platform (bbls) |
| 21 | - for cuttings/drilling muds |
| 22 | - for produced water |
| 23 | Potential additional storage capacity on platform (bbls) |
| 24 | - for cuttings/drilling muds |
| 25 | - for produced water |
| 26 | Estimated cost to install additional storage capacity on platform ($/bbl) |
| 27 | - for cuttings/drilling muds |
| 28 | - for produced water |
| 29 | Are drilling wastes treated prior to discharge? |
| 30 | - for cuttings/drilling muds |
| 31 | - for produced water |
| 32 | Attach a description of treatment equipment and processes |
| 33 | - for cuttings/drilling muds |
| 34 | - for produced water |
| 35 | If produced water is reinjected, what provisions are made when the reinjection system is not operating? |

**Table 2.**
**Water-based Muds & Drill Cuttings**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Water-based Muds & Drill Cuttings** | |
| 9 | Water-based muds (WBMs) -Total Volume used (bbls) |
| 10 | Drill cuttings generated using WBMs (bbls) |
| 11 | Percentage of WBMs on drill cuttings |
| 12 | Total volume discharged overboard (bbls) |
| 13 | Volume (or percent) transported to shore for disposal at at Class I or Class II landfills |
| 14 | Volume (or percent) transported to shore for treatment at a Company-owned facility |
| 15 | Volume (or percent) transported to shore for recycling |
| 16 | Method of transporting to shore |
| 17 | Barge |
| 18 | Tank/container on supply vessel |
| 19 | Subsea pipeline |
| 20 | Method of land transport to treatment/disposal facility |
| 21 | Road |
| 22 | Rail |
| 23 | Pipeline |
| 24 | Volume (or percent) reinjected |
| 25 | Estimated reinjection capacity (bbls) |
| 26 | Reinjection disposal rate (max, bbls/hour) |
| 27 | Aggregate annual disposal costs paid for |
| 28 | Discharge overboard (including treatment) |
| 29 | Landfill disposal |
| 30 | On-shore treatment |
| 31 | On-shore recycling |
| 32 | Offshore reinjection |

**Table 3.**
**Synthetic-Based Muds & Drill Cuttings**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Synthetic-based Muds & Drill Cuttings** | |
| 9 | Synthetic-based muds (SBMs) - Total Volume used (bbls) |
| 10 | Drill cuttings generated using SBMs (bbls) |
| 11 | Percentage of SBMs on drill cuttings |
| 12 | Total volume discharged overboard (bbls) |
| 13 | Volume (or percent) transported to shore for disposal at at Class I or Class II landfills |
| 14 | Volume (or percent) transported to shore for treatment at a Company-owned facility |
| 15 | Volume (or percent) transported to shore for recycling |
| 16 | Method of transporting to shore |
| 17 | Barge |
| 18 | Tank/container on supply vessel |
| 19 | Subsea pipeline |
| 20 | Method of land transport to treatment/disposal facility |
| 21 | Road |
| 22 | Rail |
| 23 | Pipeline |
| 24 | Volume (or percent) reinjected |
| 25 | Estimated reinjection capacity (bbls) |
| 26 | Reinjection disposal rate (max, bbls/hour) |
| 27 | Aggregate annual disposal costs paid for |
| 28 | Discharge overboard (including treatment) |
| 29 | Landfill disposal |
| 30 | On-shore treatment |
| 31 | On-shore recycling |
| 32 | Offshore reinjection |

**Table 4.**
**Oil-based Muds & Drill Cuttings**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Oil-based Muds & Drill Cuttings** | |
| 9 | Oil-based muds (OBMs) - Total Volume used (bbls) |
| 10 | Drill cuttings generated using OBMs (bbls) |
| 11 | Percentage of OBMs on drill cuttings |
| 12 | Total volume discharged overboard (bbls) |
| 13 | Volume (or percent) transported to shore for disposal at Class I or Class II landfills |
| 14 | Volume (or percent) transported to shore for treatment at a Company-owned facility |
| 15 | Volume (or percent) transported to shore for recycling |
| 16 | Method of transporting to shore |
| 17 | Barge |
| 18 | Tank/container on supply vessel |
| 19 | Subsea pipeline |
| 20 | Method of land transport to treatment/disposal facility |
| 21 | Road |
| 22 | Rail |
| 23 | Pipeline |
| 24 | Volume (or percent) reinjected |
| 25 | Estimated reinjection capacity (bbls) |
| 26 | Reinjection disposal rate (max, bbls/hour) |
| 27 | Aggregate annual disposal costs paid for |
| 28 | Discharge overboard (including treatment) |
| 29 | Landfill disposal |
| 30 | On-shore treatment |
| 31 | On-shore recycling |
| 32 | Offshore reinjection |

**Table 5.**
**Produced Water Disposal**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Produced Water** | |
| 9 | Total Volume produced (bbls) |
| 10 | Total volume discharged overboard (bbls) |
| 11 | Volume (or percent) transported to shore for disposal at at Class I or Class II landfills |
| 12 | Volume (or percent) transported to shore for treatment at a Company-owned facility |
| 13 | Volume (or percent) transported to shore for recycling |
| 14 | Method of transporting to shore |
| 15 | Barge |
| 16 | Tank/container on supply vessel |
| 17 | Subsea pipeline |
| 18 | Frequency of transport to shore (times/yr) |
| 19 | Method of land transport to treatment/disposal facility |
| 20 | Road |
| 21 | Rail |
| 22 | Pipeline |
| 23 | Volume (or percent) reinjected |
| 24 | Estimated reinjection capacity (bbls) |
| 25 | Reinjection disposal rate (max, bbls/hour) |
| 26 | Aggregate annual disposal costs paid for: |
| 27 | Discharge overboard (including treatment) |
| 28 | Landfill disposal |
| 29 | On-shore treatment |
| 30 | On-shore recycling |
| 31 | Offshore reinjection |

**Table 6.**
**Air Quality Impact Assessment**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **Air Quality Impact Assessment** | |
| 9 | If wastes are reinjected, list what type of pre-treatment and pumping equipment is used and the type of fuel used by the equipment (e.g., electric, diesel, natural gas, etc.) |
| 10 | Are evaporators used to concentrate produced water? |
| 11 | If vessel transportation to shore has been or will be used, please describe: |
| 12 | Vessel type |
| 13 | Engine type and numbers |
| 14 | Type of fuel used |
| 15 | Number of round trips per year |
| 16 | Volume per trip |
| 17 | How are wastes loaded from platform to vessel? (e.g., electric pump, diesel-fueled pump, diesel crane, etc.) |
| 18 | How are wastes offloaded from vessel to the shore facility? |
| 19 | Are storage tanks used at onshore facility for temporary storage of wastes? |
| 20 | How are wastes transported from shore facility to disposal or treatment site? |
| 21 | If tanker trucks are used, please describe: |
| 22 | Truck freight capacity |
| 23 | Distance traveled to disposal site (roundtrip) |
| 24 | Type of fuel used |
| 25 | Engine classification |

**Table 7.**
**Onsite Injection Alternative**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **If onsite injection were used as a disposal option** | |
| 9 | Describe the sources of power for the platform? (e.g., onboard generators powered by reservoir gas, onboard diesel generators, shore-based generators, State electricity grid, etc.) |
| 10 | What would be the estimated incremental increase in air emissions for operation of equipment added for treatment & injection? Alternatively, provide appropriate new equipment specifications so that increased air emissions can be estimated. |
| 11 | For drill wastes (cuttings and mud) |
| 12 | For produced water |
| 13 | Is there adequate existing space onboard to install treatment and injection equipment for drill wastes and for produced water? |
| 14 | For drill wastes (cuttings and mud) |
| | For produced water |
| 15 | If not, what is the estimated area required and cost of expanding the deck space to accommodate treatment and injection equipment? |
| 16 | For drill wastes (cuttings and mud) |
| 17 | For produced water |
| 18 | What is the estimated cost of procuring and installing needed treatment and injection equipment? |
| 19 | For drill wastes (cuttings and mud) |
| 20 | For produced water |
| 21 | What is the estimated time of construction from design to on-line operation of treatment and injection equipment? |
| 22 | For drill wastes (cuttings and mud) |
| 23 | For produced water |
| 24 | What is the estimated annual increase in operating costs (power, maintenance, man power, etc) for the new treatment/injection equipment? |
| 25 | For drill wastes (cuttings and mud) |
| 26 | For produced water |

**Table 8.**
**If Overboard Discharges were Prohibited**

| Item | Disposal Activities for Platform Name: |
|---|---|
| 1 | Operator: |
| 2 | Lease Block |
| 3 | Platform Location (Lat, Long) |
| 4 | Distance from Shore |
| 5 | Point of Contact for questions on this data submittal |
| 6 | Name: |
| 7 | Telephone: |
| 8 | Email: |
| **If all overboard discharges were prohibited** | |
| 9 | How would disposal operations change if overboard discharges of drill wastes (cuttings and muds) were prohibited? |
| 10 | Estimated annual mud volumes used (for 2007 to 2010) |
| 11 | Estimated cuttings volumes generated (for 2007 to 2010) |
| 12 | Estimated volume or percentage of cuttings injected onsite |
| 13 | Estimated volume or percentage of cuttings sent to shore |
| 14 | Method of transport of cuttings to shore (e.g., pipeline, bulk barging, marine portable tanks, etc.) |
| 15 | Method of onshore transport to disposal/treatment site |
| 16 | Estimated air emissions associated with transport to shore |
| 17 | Estimated air emissions associated with onshore transport |
| 18 | Estimated annual costs for transport to shore |
| 19 | Estimated annual costs for onshore transport and disposal or treatment/recycling |
| 20 | How would disposal operations change if overboard discharges of produced water were prohibited? |
| 21 | Estimated volume or percentage of produced water injected onsite |
| 22 | Estimated volume or percentage of produced water sent to shore |
| 23 | Method of transport of produced water to shore (e.g., pipeline, bulk barging, marine portable tanks, etc.) |
| 24 | Method of onshore transport to disposal/treatment site |
| 25 | Estimated air emissions associated with transport to shore |
| 26 | Estimated air emissions associated with onshore transport |
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# APPENDIX B
## AIR QUALITY ANALYSES

# AIR QUALITY ANALYSES

Oil and gas exploration and production (E&P) wastes routinely generated at offshore platforms include: produced water, drilling mud, and drill cuttings. Current disposal practice is overboard discharge. This project investigates other alternative methods to dispose the E&P wastes and the air quality impacts of these alternative methods. One of the alternative methods is to transport the E&P wastes onshore and dispose the wastes on land. The other alternative method is to inject the E&P wastes into the wells.

## A. Scenario – Transport and Disposal Onshore

Following is the description of each transportation route and its impacts on air quality. At the time of this analysis there were no E&P waste quantities available from Aera, therefore an air quality impact analysis cannot be assessed for the Aera's platforms. Data for the POOLLC's Houchin platform is also not available.

Review of the E&P waste profile showed that the wastes contain materials with low vapor pressure. Emissions of volatile compounds are not expected during the transport. Emissions are mainly from equipment operated to transport the wastes. For this analysis, only criteria emissions such as nitrogen oxides (NOx), carbon monoxide (CO), reactive organic gases (ROG), sulfur oxides (SOx) and particulate matters (PM) are quantified. Toxic emissions are not quantified or evaluated.

### 1. Loading E&P wastes from offshore platform on Barges

There are several potential methods to load the E&P wastes onto supply vessels. The wastes can be directly pumped to the storage containers on the supply vessels. There is minimal air quality impact for an electric pump. If the pump is powered by diesel engine, then diesel combustion generates air emissions, including: NOx, CO, SOx, ROG, and PM. The E&P wastes can also be stored in bins (or tanks) on the platform. A diesel-fueled crane can be used to load the bins onto the supply vessels. Diesel combustion from the crane will also generate similar types of air contaminants as diesel powered pumps. The air contaminants can be typically estimated based on emissions factors, engine horsepower, load factor, fuel usage and operating hours as follows:

$$Ei = EF \times HP \times LF \times Hr \qquad \text{Eq. 1}$$

Where:

| | | |
|---|---|---|
| Ei | = | Pollutant specific emissions (NOx, ROG, CO, SOx, PM) |
| EF | = | Emission factors (pounds per horsepower-hour) |
| HP | = | Engine horsepower |
| LF | = | Engine load factor |

Hr = Crane operating schedule (hours per year)

The emissions will vary substantially among the platforms, since each platform may chose different methods to load the wastes, have different quantity of wastes, and use engines with various sizes, etc.

For this analysis, it is assumed that all platforms store the E&P wastes in bins. When the bins are full, they are then loaded onto the supply vessels using a crane currently available on the platform. Each bin can store up to 23 barrels (bbls) and it takes approximately 15 minutes to unload each empty bin on the platform and then load each bin filled with E&P wastes onto the supply vessel. Information for the crane engines such as emission factors, horsepower and engine load factor were found from the platform air quality permits. Using Equation 1, estimates for the criteria emissions were generated for the bin loading operations. Table 1 shows the detailed calculations.

## 2. Supply Vessel Operation

Supply vessesl traveling between the platforms and the berths consists of the following transit segments: (1) Docking at platform, (2) Open water runs, and (3) Docking at the berth.

Emission sources include the supply vessel main propulsion engines and the auxiliary engines. The main engine is used to propel the supply vessel between the platform and the port. The auxiliary engines are used to maneuver, for docking, vessel power generation, etc. The emissions can be modeled as follows:

$$Ei = (EFm \times Fuelm \times LFm + EFa \times Fuela \times LFa) \times Hr \qquad \text{Eq. 2}$$

$$Fuelm = HPm \times SPF$$
$$Fuela = Hpa \times SPF$$

Where:
Ei = Pollutant specific emissions ($NO_x$, ROG, CO, $SO_x$, PM)
EFm = Main engine emission factor by engine type, operating mode, and fuel
HPm = Main engine horsepower
LFm = Main Engine load factor (1)
EFa = Auxiliary engine emission factor by engine type, operating mode, and fuel
HPa = Auxiliary engine horsepower
LFa = Main Engine load factor (0.5)
SFP = Specific fuel usage (0.055 gallons per horsepower-hour)
Hr = Main and auxiliary engine operating schedule (hours per year)

The platforms use various types of supply vessels to transport supplies. For this analysis, it is assumed that each supply vessel can hold 35 bins of E&P wastes per each trip. Information for the supply vessel engines such as emission factors, horsepower and engine load factor were found from the platform air quality permits. Using Equation 2, an estimate of the criteria emissions were generated for the supply vessel operations. Table 2 shows the detailed calculations.

### 3. Unloading E&P Wastes from Supply Vessels

When the supply vessels arrive at the port, there are several ways to unload the bins. The bins can be unloaded by a large crane and loaded directly onto trucks. The bins can also be unloaded by a smaller crane and forklifts can be used to load the bins onto trucks. For this analysis, it is assumed that large diesel-fuel cranes are used to load the bins directly onto trucks with approximately 30 minutes to unload each bin. It is also assumed that platform operators will use cranes similar to the ones used in their offshore platform.

The air contaminants can be typically estimated based on emissions factors, engine horsepower, load factor, fuel usage and operating hours as follows:

$$Ei = EF \times HP \times LF \times Hr \qquad \text{Eq. 3}$$

Where:

| | | |
|---|---|---|
| Ei | = | Pollutant specific emissions (NOx, ROG, CO, SOx, PM) |
| EF | = | Emission factors (pounds per horsepower-hour) |
| HP | = | Engine horsepower |
| LF | = | Engine load factor |
| Hr | = | Crane operating schedule (hours per year) |

Information for the crane engines such as emission factors, horsepower and engine load factor were found from the platform air quality permist. Using Equation 3, an estimate of the criteria emissions were generated for the onshore crane operations. Table 3 shows the detailed calculations.

### 4. Transportation of E&P Wastes to a Landfill Disposal Site

Emissions from diesel trucks hauling E&P wastes to the landfill disposal site must be accounted for. These on-road vehicle emissions were estimated using CARB's Mobile Vehicle Emission Inventory Program (EMFAC2002). This EMFAC2002 program provides an emission factor in pounds per mile traveled. The emissions are then computed as follows:

$$Ei = EF \times Mile \qquad \text{Eq. 4}$$

Where

| | | |
|---|---|---|
| Ei | = | Pollutant specific emissions (NOx, ROG, CO, SOx, PM) |
| EF | = | Emission factors (pounds per miles traveled) |
| Mile | = | Mile traveled (miles traveled per year by truck) |

For this analysis, it is assumed that each truck can hold 2 bins of E&P wastes per each trip. It is also assumed that each diesel-fueled truck will travel 300 miles round trip.

Using Equation 4, an estimate of the criteria emissions were generated for the truck transport operations. Table 4 shows the detailed calculations.

## 5. Unloading E&P Wastes from Trucks at the Landfill Disposal Site

When the trucks arrive at the landfill disposal site, equipment used to unload the bins can generate emissions. For this analysis, it is assumed that a large diesel-fuel crane is used to unload the bins, taking approximately 30 minutes to unload each bin. It is also assumed that landfill operators will utilize a crane similar to the one used in their offshore platform.

The air contaminants can be typically estimated based on emissions factors, engine horsepower, load factor, fuel usage and operating hours as follows:

$$Ei = EF \times HP \times LF \times Hr \qquad \text{Eq. 5}$$

Where:

| | | |
|---|---|---|
| Ei | = | Pollutant specific emissions (NOx, ROG, CO, SOx, PM) |
| EF | = | Emission factors (pounds per horsepower-hour) |
| HP | = | Engine horsepower |
| LF | = | Engine load factor |
| Hr | = | Crane operating schedule (hours per year) |

Information for the crane engines such as emission factors, horsepower and engine load factor were found from the platform air quality permits. Using Equation 5, an estimate of the criteria emissions was generated for landfill unloading operation. Table 5 shows the detailed calculations. It is also assumed that the E&P wastes will be buried at the disposed site, and there are no other handling operations of the wastes, such as incineration treatment, evaporation, etc. Other minor emissions are also not considered in this analysis, such as PM emissions from trucks traveling on unpaved roads.

## 6. Total Emissions for Disposal Onshore

Table 6 summarizes the total emissions for the option to dispose the E&P wastes onsite for each platform. For example, the option to dispose the E&P wastes from the Arguello's Harvest platform will result in total emissions of 24 tons per year NOx, 2.0 tons per year ROG, 7.6 tons per year CO, 2.4 tons per year SOx and 2.2 tons per year PM.

## B. Scenario – Offshore Injection

Injection of the E&P wastes into wells is other disposal option being evaluated. For each barrel of E&P waste, 2.5 barrels of seawater is required to make the slurry for injection. Emissions are mainly from the diesel-fueled pumps needed to drive the injection process.

The air contaminants from the pumps can be typically estimated based on emissions factors, engine horsepower, load factor, fuel usage and operating hours as follows:

$$Ei = EF \times HP \times LF \times Hr \qquad \text{Eq. 6}$$

$$Hr = Slurry/Rate$$

$$Slurry = 2.5 \times Q$$

Where:

| | | |
|---|---|---|
| Ei | = | Pollutant specific emissions (NOx, ROG, CO, SOx, PM) |
| EF | = | Emission factors (pounds per horsepower-hour) |
| HP | = | Engine horsepower |
| LF | = | Engine load factor |
| Hr | = | Pump engine operating schedule (hours per year) |
| Slurry | = | Mixture of seawater and E&P wastes |
| Rate | = | Pump capacity (2.5 bbl per minute) |
| Q | = | E&P waste quantity |

For Exxon Mobile platforms, specific pumps and emission factors are available. These specific parameters are used to compute the increases to the criteria emissions. Using Equation 6 an estimate of the criteria emissions was generated for the injection operations. Table 7 shows the detailed calculations.

There is no information available from other platform operators for the injection pump engines such as emission factors, horsepower and engine load factor.

## C. Air Quality Permit Requirements

The platform operation is subject to local air quality rules and regulations. The local air quality agencies include the following:

- Aera Energy LLC Platforms – South Coast Air Quality Management District (SCAQMD)
- ExxonMobil Platforms – Santa Barbara Air Pollution Control District (SBAPCD)
- Pacific Operators Offshore LLC Platforms – SBAPCD
- Venoco Inc. Platforms – Ventura Air Pollution Control District
- Plains Exploration and Production Platform - SBAPCD
- Arguello Inc. Platforms – SBAPCD

Current permits issued by the applicable air quality regulatory agencies identify the equipment on the platforms and also establishes emission limits for each individual equipment and the overall emissions from the platforms. The emissions limits are established based on specific rules and regulations of the applicable air quality regulatory agencies. In general, the most important rules are the New Source Resources (NSR) regulations. Any emissions increases from equipment due to an alternative discharge operation will be subject to the NSR regulations. The purpose of NSR is to ensure that the operation of the emission sources does not interfere with progress in attainment of the national ambient air quality standards. In general, the NSR is triggered when there is an emission increase from a proposed operation. For example, if the emissions from the crane engines used during bin loading/unloading operations exceed the current emission limit specified in the permit, NSR will be applied. NSR specifically requires the following:

<u>Best Available Control Technology</u>
BACT is required for new or modified equipment if operation of the new or modified equipment results in increases of criteria emissions. Diesel fueled equipment including cranes, supply vessels, and pumps would be used in the alternative discharge operations. Typical BACT for these equipment include catalytic converters, diesel particulate filters, selective catalytic reduction, etc. Selection of the BACT depends on various factors, such as economic feasibility, hardware compatibility, control efficiency, and air quality agency acceptance, etc.

<u>Air Quality Impact Analysis (AQIA) Requirement</u>
AQIA is required if operation of the new or modified equipment results in increases of criteria emissions. The AQIA shall demonstrate that the emission increases will not cause a violation or interfere with the expeditious attainment or maintenance of any national primary ambient air quality standard.

<u>Emission Offsets Requirement</u>
Emission reduction credits (ERC) are required if operation of the new or modified equipment results in increases of criteria emissions. The ERCs shall be used to mitigate the net emission increases from the equipment. The platform operator can purchase ERCs from outside sources to cover its proposed new or modified equipment used for the alternative discharge option. There are few ERCs for sale. Obtaining sufficient ERCs to cover the emission increases should be considered one of deciding factors to implement the alternative discharge options.

The Aera platforms are subject to the SCAQMD's RECLAIM program. In addition to the NSR requirement as described above, the RECLAIM program will require Aera to secure sufficient NOx RECLAIM Trading Credits (RTCs) for any emission increases over the NOx allocations.

In summary, NSR compliance should be analyzed in detail to ensure that applicable air quality permits can be secured from the local air quality agency for implementing the alternative discharge options.

TABLE 1. PLATFORM UNLOADING EMISSIONS

| Company | Platform | WBM & cuttings, bbl/yr Note (5) | Nos of bin/yr (Note 1) | Crane Engine HP (Note 2) | % Engine Loading | Engine Hours, hour/yr (Note 3) | Criteria Air Pollutants Emissions, lb/yr (Note 4) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest | 29,900 | 1,300 | 503 | 1 | 325 | 3,025 | 404 | 1,092 | 335 | 360 |
| | Hermosa | 29,900 | 1,300 | 475 | 1 | 325 | 2,856 | 381 | 1,031 | 316 | 340 |
| | Hildago | 29,900 | 1,300 | 475 | 1 | 325 | 2,856 | 381 | 1,031 | 316 | 340 |
| ExxonMobil | Harmony | 170,000 | 7,391 | 450 | 1 | 1,848 | 15,385 | 2,054 | 5,555 | 1,705 | 1,829 |
| | Heritage | 136,000 | 5,913 | 450 | 1 | 1,478 | 12,308 | 1,643 | 4,444 | 1,364 | 1,463 |
| | Hondo | 85,000 | 3,696 | 160 | 1 | 924 | 2,735 | 365 | 987 | 303 | 325 |
| POOLLC | Hogan | 0 | 0 | 230 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Houchin | 14,400 | 626 | 230 | 1 | 157 | 666 | 89 | 240 | 74 | 79 |
| PXP | Irene | 54,700 | 2,378 | 210 | 1 | 595 | 2,310 | 308 | 834 | 256 | 275 |
| Veneco | Gail | 6,231 | 271 | 545 | 1 | 68 | 683 | 91 | 247 | 76 | 81 |
| | Grace | 6,231 | 271 | 300 | 1 | 68 | 376 | 50 | 136 | 42 | 45 |

Notes

1 Based on 23 barrel per bin
2 Source: Air Quality Permit
3 Based on 15 minutes to load each bin onto barge
4 Based on emission factors for each pollutant specified in air quality permit

TABLE 2. BARGE OPERATION EMISSIONS

| Company | Platform | WBM & Cutting, bbl/yr | Nos of bin/yr (Note 1) | Nos. of trip/yr (Note 2) | Distance to Port (one way), mile | Miles Travelled, miles/yr | Boat Engine, Hr/yr (Note 3) | Boat Main Engine, HP (Note 4) | Boat Auxilliary Engines, HP (Note 4) | Boat Main Engine Fuel Usage, gal/yr (Note 5) | Boat Auxillary Engine Fuel Usage, gal/yr (Note 5) | Criteria Air Pollutants Emissions, lb/yr (Note 6) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest | 29,900 | 1,300 | 37 | 86 | 6,389 | 532 | 5,000 | 1,005 | 146,405 | 29,427 | 40,870 | 2,319 | 9,353 | 4,483 | 3,761 |
| | Hermosa | 29,900 | 1,300 | 37 | 84 | 6,240 | 520 | 5,000 | 1,005 | 143,000 | 28,743 | 39,947 | 2,265 | 9,136 | 4,384 | 3,674 |
| | Hildago | 29,900 | 1,300 | 37 | 90 | 6,686 | 557 | 5,000 | 1,005 | 153,214 | 30,796 | 42,800 | 2,427 | 9,788 | 4,697 | 3,936 |
| ExxonMobil | Harmony | 170,000 | 7,391 | 211 | 57 | 24,075 | 2,006 | 4,000 | 1,309 | 441,366 | 144,437 | 140,012 | 8,358 | 31,801 | 10,127 | 12,515 |
| | Heritage | 136,000 | 5,913 | 169 | 62 | 20,949 | 1,746 | 4,000 | 1,309 | 384,066 | 125,686 | 121,835 | 7,273 | 27,673 | 8,812 | 10,890 |
| | Hondo | 85,000 | 3,696 | 106 | 55 | 11,615 | 968 | 4,000 | 1,309 | 212,940 | 69,685 | 67,550 | 4,033 | 15,343 | 4,886 | 6,038 |
| POOLLC | Hogan | 0 | 0 | 0 | 23 | 0 | 0 | 2,250 | 584 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Houchin | 14,400 | 626 | 18 | 24 | 859 | 72 | 2,250 | 584 | 8,855 | 2,298 | 2,629 | 155 | 614 | 196 | 231 |
| PXP | Irene | 54,700 | 2,378 | 68 | 95 | 12,911 | 1,076 | 4,000 | 755 | 236,694 | 44,676 | 51,404 | 3,679 | 14,935 | 4,969 | 6,020 |
| Veneco | Gail | 6,231 | 271 | 8 | 11 | 170 | 14 | 5,000 | 700 | 3,902 | 546 | 790 | 56 | 234 | 79 | 95 |
| | Grace | 6,231 | 271 | 8 | 14 | 217 | 18 | 5,000 | 700 | 4,967 | 695 | 1,006 | 71 | 298 | 101 | 121 |

Notes

1. Based on 23 barrel per bin
2. Based on 35 bins per barge
3. Based on 12 mile per hour for boat speed
4. Source: Air Quality Permit
5. Based on 0.055 gal/HP-Hr (Source: Air Quality Permit)
6. Based on emission factors for each pollutant specified in air quality permit

TABLE 3. BARGE UNLOADING EMISSIONS

| Company | Platform | WBM & Cutting, bbl/yr | Nos of bin/yr (Note 1) | Crane Engine HP (Note 2) | % Engine Loading | Engine Hours, hour/yr (Note 3) | Criteria Air Pollutants Emissions, lb/yr (Note 4) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest, Hermosa, Hildago | 89,700 | 3,900 | 503 | 1 | 1,950 | 18,148 | 2,423 | 6,552 | 2,011 | 2,158 |
| ExxonMobil | Harmony, Heritage, Hondo | 391,000 | 17,000 | 450 | 1 | 8,500 | 70,771 | 9,448 | 25,551 | 7,841 | 8,415 |
| POOLLC | Hogan, Houchin | 14,400 | 626 | 920 | 1 | 313 | 5,329 | 711 | 1,924 | 590 | 634 |
| PXP | Irene | 54,700 | 2,378 | 210 | 1 | 1,189 | 4,620 | 617 | 1,668 | 512 | 549 |
| Veneco | Gail, Grace | 12,462 | 542 | 545 | 1 | 271 | 2,732 | 365 | 986 | 303 | 325 |

Notes

1 Based on 23 barrel per bin and 35 bins per barge

2 Source: Air Quality Permit. For POOLLC, assume 4 engines with 230 HP each to keep up with the E&P quantity. For example, each crane operates 24/7/365 for 8,760 hr/yr

3 Based on 30 minutes to upload each bin from barge

4 Based on emission factors for each pollutant specified in air quality permit

TABLE 4. TRUCK EMISSIONS

| Company | Platform | WBM & Cutting, bbl/yr | Nos. of bin/yr | Nos. of trip/yr (Note 1) | Distance to Disposal Site (one way), mile | Miles Travelled, miles/yr | Criteria Air Pollutants Emissions, lb/yr (Note 2) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest | 29,900 | 1,300 | 650 | 150 | 195,000 | 6,086 | 656 | 4,974 | 47 | 196 |
| | Hermosa | 29,900 | 1,300 | 650 | 150 | 195,000 | 6,086 | 656 | 4,974 | 47 | 196 |
| | Hildago | 29,900 | 1,300 | 650 | 150 | 195,000 | 6,086 | 656 | 4,974 | 47 | 196 |
| ExxonMobil | Harmony | 170,000 | 7,391 | 3,696 | 150 | 1,108,696 | 34,600 | 3,727 | 28,281 | 267 | 1,112 |
| | Heritage | 136,000 | 5,913 | 2,957 | 150 | 886,957 | 27,680 | 2,982 | 22,624 | 214 | 890 |
| | Hondo | 85,000 | 3,696 | 1,848 | 150 | 554,348 | 17,300 | 1,864 | 14,140 | 134 | 556 |
| POOLLC | Hogan | 0 | 0 | 0 | 150 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Houchin | 14,400 | 626 | 313 | 150 | 93,913 | 2,931 | 316 | 2,396 | 23 | 94 |
| PXP | Irene | 54,700 | 2,378 | 1,189 | 150 | 356,739 | 11,133 | 1,199 | 9,100 | 86 | 358 |
| Veneco | Gail | 6,231 | 271 | 135 | 150 | 40,637 | 1,268 | 137 | 1,037 | 10 | 41 |
| | Grace | 6,231 | 271 | 135 | 150 | 40,637 | 1,268 | 137 | 1,037 | 10 | 41 |

Notes

1 Based on 2 bins per truck

2 Based on emission factors from California Air Resources Board EMFAC2002 Model Run
www.carb.ca.gov/msei/onroad/latest_version.htm

TABLE 5. DISPOSAL SITE UNLOADING EMISSIONS

| Company | Platform | WBM & Cutting, bbl/yr | Nos of bin/yr (Note 1) | Crane Engine HP (Note 2) | % Engine Loading | Engine Hours, hour/yr (Note 3) | Criteria Air Pollutants Emissions, lb/yr (Note 4) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest, Hermosa, Hildago | 89,700 | 3,900 | 503 | 1 | 1,950 | 18,148 | 2,423 | 6,552 | 2,011 | 2,158 |
| ExxonMobil | Harmony, Heritage, Hondo | 391,000 | 17,000 | 450 | 1 | 8,500 | 70,771 | 9,448 | 25,551 | 7,841 | 8,415 |
| POOLLC | Hogan, Houchin | 14,400 | 626 | 920 | 1 | 313 | 5,329 | 711 | 1,924 | 590 | 634 |
| PXP | Irene | 54,700 | 2,378 | 210 | 1 | 1,189 | 4,620 | 617 | 1,668 | 512 | 549 |
| Veneco | Gail, Grace | 12,462 | 542 | 545 | 1 | 271 | 2,732 | 365 | 986 | 303 | 325 |

Notes

1 Based on 23 barrel per bin and 35 bins per barge

2 Source: Air Quality Permit. For POOLLC, assume 4 engines with 230 HP each to keep up with the E&P quantity. For example, each crane operates 24/7/365 for 8,760 hr/yr

3 Based on 30 minutes to upload each bin from truck

4 Based on emission factors for each pollutant specified in air quality permit

TABLE 6. TOTAL EMISSIONS FOR ONSHORE DISPOSAL

| Company | Platform | Platform Unloading, lb/yr | | | | | Barge Operation, lb/yr | | | | | Barge Unloading, lb/yr | | | | | Truck Transport, lb/yr | | | | | Site Unloading, lb/yr | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NOx | ROG | CO | SOx | PM | NOx | ROG | CO | SOx | PM | NOx | ROG | CO | SOx | PM | NOx | ROG | CO | SOx | PM | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest | 3,025 | 404 | 1,092 | 335 | 360 | 40,870 | 2,319 | 9,353 | 4,483 | 3,761 | 18,148 | 2,423 | 6,552 | 2,011 | 2,158 | 6,086 | 656 | 4,974 | 47 | 196 | 18,148 | 2,423 | 6,552 | 2,011 | 2,158 |
| | Hermosa | 2,856 | 381 | 1,031 | 316 | 340 | 39,947 | 2,265 | 9,136 | 4,384 | 3,674 | | | | | | 6,086 | 656 | 4,974 | 47 | 196 | | | | | |
| | Hildago | 2,856 | 381 | 1,031 | 316 | 340 | 42,800 | 2,427 | 9,788 | 4,697 | 3,936 | | | | | | 6,086 | 656 | 4,974 | 47 | 196 | | | | | |
| ExxonMobil | Harmony | 15,385 | 2,054 | 5,555 | 1,705 | 1,829 | 140,012 | 8,358 | 31,801 | 10,127 | 12,515 | 70,771 | 9,448 | 25,551 | 7,841 | 8,415 | 34,600 | 3,727 | 28,281 | 267 | 1,112 | 70,771 | 9,448 | 25,551 | 7,841 | 8,415 |
| | Heritage | 12,308 | 1,643 | 4,444 | 1,364 | 1,463 | 121,835 | 7,273 | 27,673 | 8,812 | 10,890 | | | | | | 27,680 | 2,982 | 22,624 | 214 | 890 | | | | | |
| | Hondo | 2,735 | 365 | 987 | 303 | 325 | 67,550 | 4,033 | 15,343 | 4,886 | 6,038 | | | | | | 17,300 | 1,864 | 14,140 | 134 | 556 | | | | | |
| POOLLC | Hogan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,329 | 711 | 1,924 | 590 | 634 | 0 | 0 | 0 | 0 | 0 | 5,329 | 711 | 1,924 | 590 | 634 |
| | Houchin | 666 | 89 | 240 | 74 | 79 | 2,629 | 155 | 614 | 196 | 231 | | | | | | 2,931 | 316 | 2,396 | 23 | 94 | | | | | |
| PXP | Irene | 2,310 | 308 | 834 | 256 | 275 | 51,404 | 3,679 | 14,935 | 4,969 | 6,020 | 4,620 | 617 | 1,668 | 512 | 549 | 11,133 | 1,199 | 9,100 | 86 | 358 | 4,620 | 617 | 1,668 | 512 | 549 |
| Veneco | Gail | 683 | 91 | 247 | 76 | 81 | 790 | 56 | 234 | 79 | 95 | 2,732 | 365 | 986 | 303 | 325 | 1,268 | 137 | 1,037 | 10 | 41 | 2,732 | 365 | 986 | 303 | 325 |
| | Grace | 376 | 50 | 136 | 42 | 45 | 1,006 | 71 | 298 | 101 | 121 | | | | | | 1,268 | 137 | 1,037 | 10 | 41 | | | | | |

| Company | Platform | Total Emissions, ton/yr | | | | |
|---|---|---|---|---|---|---|
| | | NOx | ROG | CO | SOx | PM |
| Arguello | Harvest | 31 | 2.5 | 9.9 | 3.1 | 2.9 |
| | Hermosa | 30 | 2.5 | 9.8 | 3.0 | 2.8 |
| | Hildago | 32 | 2.5 | 10.1 | 3.2 | 3.0 |
| ExxonMobil | Harmony | 119 | 10.2 | 41.3 | 8.7 | 10.5 |
| | Heritage | 105 | 9.1 | 35.9 | 7.8 | 9.4 |
| | Hondo | 67 | 6.3 | 23.8 | 5.3 | 6.3 |
| POOLLC | Hogan | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Houchin | 8 | 1.0 | 3.5 | 0.7 | 0.8 |
| PXP | Irene | 37 | 3.2 | 14.1 | 3.2 | 3.9 |
| Veneco | Gail | 2.7 | 0.3 | 1.3 | 0.2 | 0.3 |
| | Grace | 2.7 | 0.3 | 1.2 | 0.2 | 0.3 |

TABLE 7. EMISSIONS FOR RE-INJECTION

| Company | Platform | WBM, bbl/yr | Slurry, bbl/yr (Note 1) | Pump Engine HP (Note 2) | % Engine Loading | Engine Hours, hour/yr (Note 3) | Criteria Air Pollutants Emissions, lb/yr (Note 4) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NOx | ROG | CO | SOx | PM |
| ExxonMobil | Harmony | 170,000 | 425,000 | 340 | 1 | 2833 | 29,863 | 2,023 | 6,454 | 2,216 | 2,119 |
| | Heritage | 136,000 | 340,000 | 340 | 1 | 2267 | 23,891 | 1,618 | 5,163 | 1,773 | 1,695 |
| | Hondo | 85,000 | 212,500 | 340 | 1 | 1417 | 14,932 | 1,012 | 3,227 | 1,108 | 1,060 |

| Company | Platform | Total Emissions, ton/yr | | | | |
|---|---|---|---|---|---|---|
| | | NOx | ROG | CO | SOx | PM |
| ExxonMobil | Harmony | 14.93 | 1.01 | 3.23 | 1.11 | 1.06 |
| | Heritage | 11.95 | 0.81 | 2.58 | 0.89 | 0.85 |
| | Hondo | 7.47 | 0.51 | 1.61 | 0.55 | 0.53 |

Notes

1 Based on mixture of 2.5 bbl seawater and 1 bbl E&P wastes
2 Based on estimated pump power required.
3 Based on each pump capacity of 2.5 bbl per minute
4 Based on emission factors for each pollutant specified in air quality permit